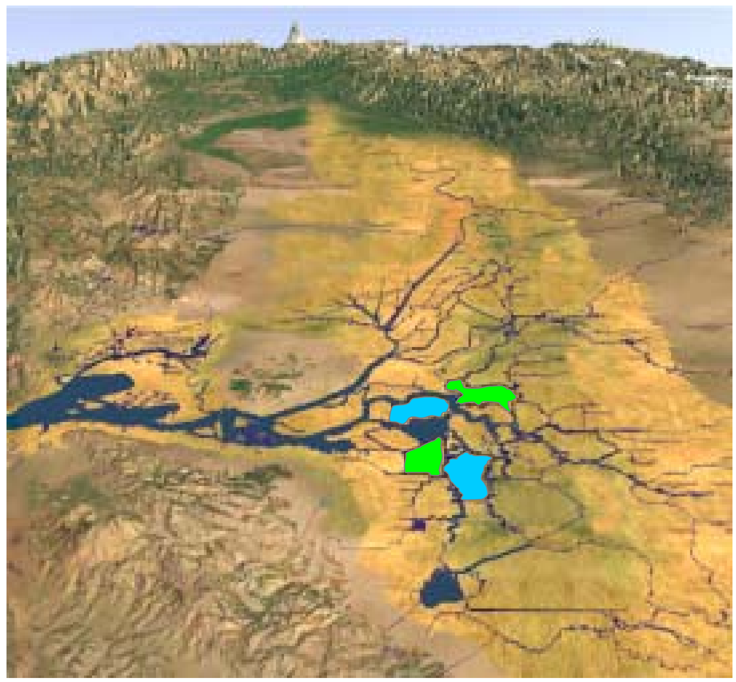
IN-DELTA STORAGE PROGRAM
STATE FEASIBILITY STUDY
DRAFT REPORT ON OPERATIONS

INTEGRATED STORAGE INVESTIGATIONS



CALIFORNIA BAY-DELTA AUTHORITY

Division of Planning and Local Assistance
Department of Water Resources

December 2003

ORGANIZATION

FOREWORD

We acknowledge the technical assistance provided by Reclamation in carrying out the role of federal lead agency for the CALFED Integrated Storage Investigations. Reclamation will continue to provide technical assistance through the review of the State Feasibility Study reports and DWR will work with Reclamation to incorporate comments and recommendations in the final reports.

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Chapter 1: Introduction

1.1 General

The purpose of conducting operational studies was to evaluate the potential benefits of the In-Delta Storage Project in terms of ecosystem enhancement of the Bay-Delta estuary and improvement in the supply and reliability of water supply systems for the State and Central Valley users. Addition of the In-Delta Storage Project to the Central Valley Project (CVP) and State Water Project (SWP) systems could have beneficial or adverse impacts to the existing water supply systems and Delta ecosystems. With that said, evaluations of potential benefits and impacts of the planned reservoirs are important to highlight the rational of the planned project and justifications for its construction costs. As the project is supposed to meet water quality requirements under the urban intakes drinking water quality standards, an acceptable In-Delta Storage operation is necessary to resolve water quality issues.

This report presents information on operational studies conducted to determine the project yield while meeting requirements under SWRCB D1641 May 1995 Water Quality Control Plan (WQCP), Water Right Decision 1641, Water Right Decision 1643, CUWA Water Quality Management Plan (WQMP) and biological opinions. California Simulation Model II (CALSIM) and the Delta Simulation Model (DSM2) were used to simulate reservoir operations and water quality.

1.2 Project Background

The proposed In-Delta Storage Project (Figure 1.1) consists of creating two reservoir islands (Webb tract and Bacon Island) and two habitat islands (Holland Tract and Bouldin Island) all located in the Sacramento-San Joaquin River Delta. The In-Delta Storage Project envisions the diversion of water onto the reservoirs during the winter season, when there is plenty of water in the Delta. The stored water will be released back into the system during the spring and summer when demand is high and supply is low.

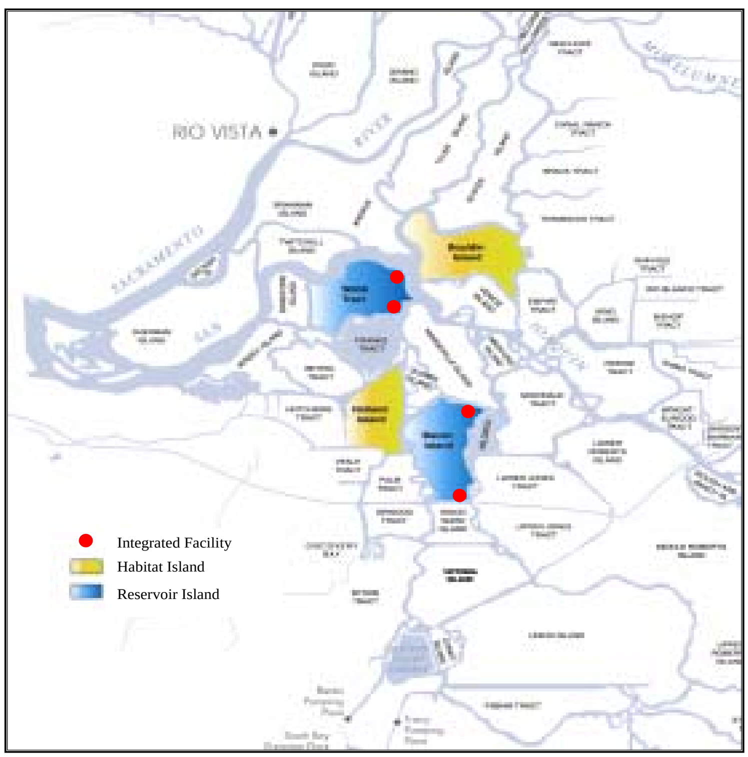


Figure 1.1: In-Delta Storage Project Islands and Integrated Facility Locations

Maximum Diversions and releases from outlet structures are shown in Figures 1.2 and 1.3. The exchange of water to and from the reservoirs will be made through four Integrated Facilities (two structures on each of the storage islands). The combined storage capacity of the reservoirs is 217 TAF and the maximum permitted diversion rate onto the reservoir islands and habitat islands is 9,000 cubic feet per second (cfs). The maximum allowable release rate is not mentioned in the water rights permit; however, the integrated facilities design allows a total release rate of 9,000 cfs from both reservoir islands.

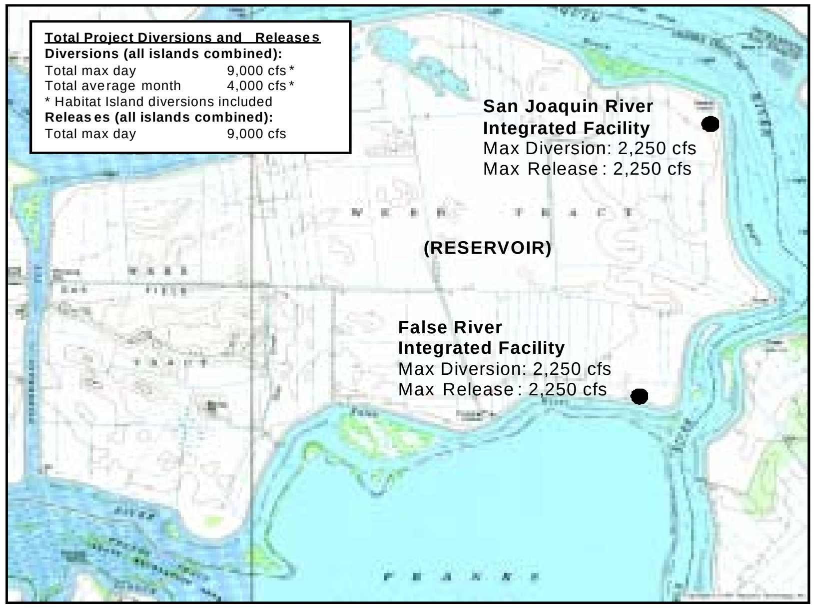


Figure 1.2: Webb Tract Storage and Integrated Facilities

Some of the main benefits of the In-Delta Storage Project are as follows:

- Provide water to meet Delta Standards and supplement flows released by SWP and CVP to meet such standards. The project is strategically situated to manage Delta conditions and respond over shorter time spans.
- Create additional benefits for environmental purposes (EWA, CVPIA, ERP). It would not create any new water for EWA but would add flexibility to the system for times when EWA can restrict exports and then make up for export reductions by using the stored water in the Delta. The project could improve flow releases and export timing to benefit Delta fisheries and improve water quality for fish in the Delta.
- Increase reliability and flexibility through additional water supply and increase in upstream carryover. The additional water supply should result from capturing surplus flows in the Delta. Also water stored during excess periods when released for Delta requirements, may result in savings for projects and can end up as additional carryover in SWP and CVP reservoirs**.**

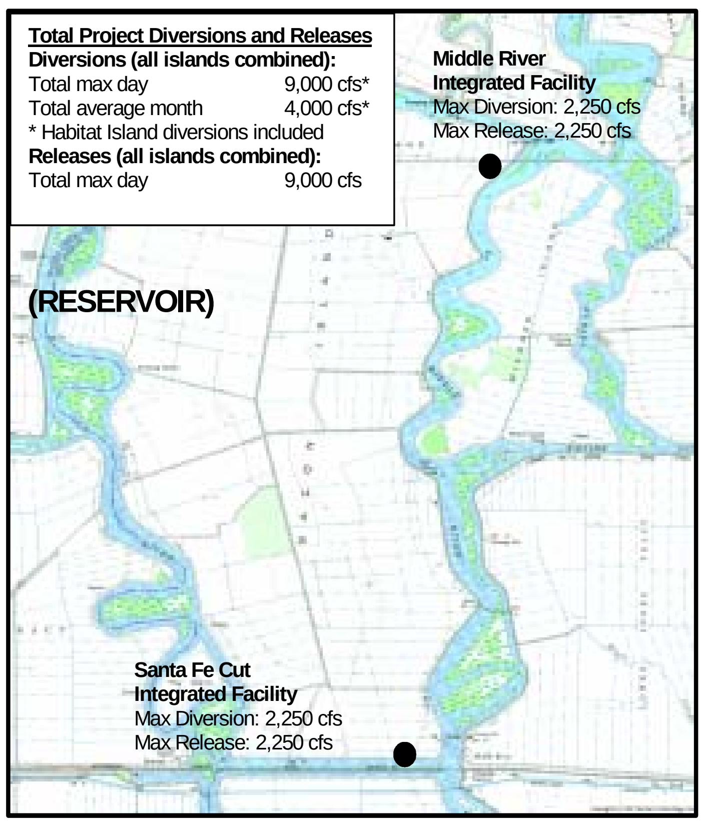


Figure 1.3: Bacon Island Storage and Integrated Facilities

- Provide storage and water marketing for sale, exchange, lease or transfer of water from one user to another.

1.3 Operational Concept

In-Delta Storage reservoirs will be operated as a component of the SWP and CVP systems (Public Ownership). Thus, in addition to Water Right Decision 1643 and the CUWA Water Quality Management Plan, the operation rules will be based on the water quality constraints set forth by the SWRCB May 1995 WQCP, Water Right Decision 1641, biological opinions, and other existing flow and water quality standards of the Delta.

Operational studies were conducted with the California Simulation Model II (CALSIM II) and the Delta Simulation Model (DSM2). As standards in the Delta are daily standards, daily versions of these models were used. A number of operational scenarios were designed to evaluate the impacts of the planned project into several aspects of the Delta systems. Each scenario differs in terms of operational constraints, regulatory standards, and water demand. Operational studies modeled with CALSIM simulate the 73-year period from WY1922 through WY1994, whereas operational studies modeled with DSM2 simulate the 16-year period from WY1974 through WY1991. The operational studies assume a 2020 level of development and hydrology. Project yield from each operational scenario is compared to the yield from a No-Action Base study, which represents the existing system configuration under 2020 level of development and hydrology. Additional information on operating criteria and use of models is presented in Chapters 2 and 3.

1.4 Key Findings and Recommendations

Based upon the CALSIM operational studies, the In-Delta Storage reservoirs will have the following beneficial impacts in the Delta and system-wide benefits for the SWP and CVP.

- Due to strategic location, the operation of the island reservoirs would contribute to operational flexibility of the SWP and CVP systems. In-Delta Storage reservoirs would provide new additional supplies for SWP and CVP users, Environmental Water Account flexibility, and flows for the Ecosystem Restoration Program. It would also create additional carryover storage in upstream CVP and SWP reservoirs.

- Coordinated operation of CVP and SWP would help meet the ecosystem needs of the Delta. Future operations can be refined in consultations with regulatory agencies for improvements in habitat quality and availability for fish and other aquatic organisms inhabiting the Bay-Delta system. The timing of environmental water allocations would be flexible depending on the specific environmental benefit to be achieved (e.g. protection of spring-run chinook salmon and delta smelt).

- Due to the possibility of carryover storage in the upstream SWP and CVP reservoirs as a result of storing water in the Delta, CALFED's ERP and storage programs should work closely with regulatory agencies to maximize the program benefits and assure compliance of the Endangered Species Act.

- EWA could realize benefits by IDS releases that are dedicated to make up for export curtailments taken to protect fisheries.

- Due to strategic location of the In-Delta Storage reservoirs, immediate actions can be taken for salinity control. The reservoirs have a favorable impact to the location of the X2 line in the Delta.

- DOC water quality problems can be diluted, with minor impacts to water supplies, using circulation operations.

- A coordinated operational study with In-Delta Storage and Los Vaqueros Reservoir Expansion indicates both projects can share Delta surplus flows. Further studies should be conducted to refine the extent of project benefits.

- Comparative information on the other three storage programs (Shasta Enlargement, Sites Reservoir and Storage in the San Joaquin River Basin) could not be completed in this feasibility study as these projects are at different levels of evaluation.

Chapter 2: Operational Criteria

2.1 Introduction

This chapter summarizes the level of development used for the feasibility study evaluations, as well as the operational rules that must be met in order to operate existing and planned projects in the Sacramento-San Joaquin Delta.

2.2 Level of Development

At the start of the feasibility study, evaluations were planned to be based on a 2030 level of development and hydrology. However, 2030 level hydrology is currently being developed under the Common Assumptions multi-agency task that may be completed during the next year. The State Feasibility Study evaluations, therefore, assume a 2020 level of development for the No-Action Base and "with project" conditions. Although a land use change is expected from the present to the 2020 level planning horizon, hydrological studies indicate that future 2020 level hydrology based water supply may not show appreciable change.

With the projected increase in population, water demands are expected to change. The projected demand for the State Water Project varies between 3.4 MAF and 4.2 MAF per year and the maximum interruptible demand is 134 TAF per month. The projected Central Valley Project demand is 3.5 MAF per year, which includes the annual Level II Refuge demand of 288 TAF. The Cross Valley Canal demand is 128 TAF per year. Trinity River Minimum Fish flows below Lewiston Dam are maintained at 369 TAF per year.

Currently, the SWP and CVP systems are being operated according to the 1995 Water Quality Control Plan (SWRCB Water Right Decision 1641). The existing system represents the 2001 level of hydrology, water demands, facilities, D1641 regulatory standards and COA operations.

2.3 Operational Criteria for the No-Action Base Alternative

Modeling applications developed under the Common Assumptions interagency effort, which represent common base operational criteria for all five surface storage projects, are to be used for the In-Delta Storage Project evaluations. Details of the No-Action Base alternative assumptions are given at the end of this chapter in Table 2.1. A summary of the criteria applied to the No-Action Base alternative is discussed below.

2.3.1 Water Quality Control Plan (D1641) Requirements

The diversion flow and water quality criteria set forth by the 1995 Water Quality Control Plan (1995 WQCP), D1641, are shown in Figure 3.1. The Water Quality Control Plan (D1641) sets operational rules to meet flow standards and water quality standards in the Delta. Key provisions of the 1995 WQCP are as follows.

- Under flow standards, the plan specifies the upper limits on exports amounts.

- It also specifies the minimum flow requirements for water quality objectives for agriculture, municipal, industrial, and fish and wildlife at key locations in the Delta and the operation schedules of the Delta Cross Channel.
- The water quality standards deal with water quality issues at export locations, interior of the Delta and the western Delta. It also specifies the limits of water quality for salinity at San Joaquin River and Suisun Marsh.
- For the upstream reservoir operations, CVPIA in-stream flow operations are represented by the modeling criteria for the Department of the Interior's Final Administrative Proposal on the Management of Section 3406(b)(2) Water, November 1997.

The diversion flow and water quality criteria set forth by the D1641 are summarized below and in Figure 2.1.

- The maximum 3-day running average combined export (which includes Tracy Pumping Plant and Clifton Court Forebay less Byron Bethany pumping) for the period of April 15 through May 15 should be greater of 1,500 cfs or 100% of 3-day average of Vernalis flow. This time period may need adjustments to coincide with fish migration and the maximum export rate and may be varied by CALFED opinion group.
- For the months of March through June, the maximum Export/Inflow ratio should be equal or less than 0.35. For rest of the months it should be less than 0.65. The definition of export and inflow are given in the footnote of Table 2.2.
- From July through January, the minimum Delta outflow should be between 3,000-8,000 cfs. As explained in Table 2.2, this quantity changes depending upon the type of year.
- From February through June, daily average flow amounting from 7,100 cfs to 29,200 cfs should be allowed as the habitat protection outflow.
- Minimum monthly average flow for September through December at Rio Vista should be kept between 3,000 to 4,500 cfs. For this period, the 7-day running average flow shall not be less than 1,000 cfs below the monthly target value.
- Depending upon the type of year, minimum average flow at Vernalis for the period of February through 15 of April should not be less than 710- 3,420 cfs.
- The Delta Cross Channel should remain closed from November through 15 July.
- At all export locations, the Chlorides (CL) concentration should be less than 250 mg/l for all months of the year.
- The year round mean daily Chlorides (CL) concentration at Contra Costa Canal intake must less than 150 mg/l.
- From the agricultural considerations and for the Western and Interior Delta, the 14 day running average EC between April and 15 of August should be less than 0.45 mS. For the South Delta, April through August 30-day moving average EC should be less than 0.7mS. For the rest of the months, it should be less than 1.0mS.
- The 14-day moving average EC at San Joaquin River salinity between Jersey Point and Pioneers Point for April and May should be below 0.14 mS. Recommended salinity requirements at Suisan Marsh area are summarized in Figure 2.1.

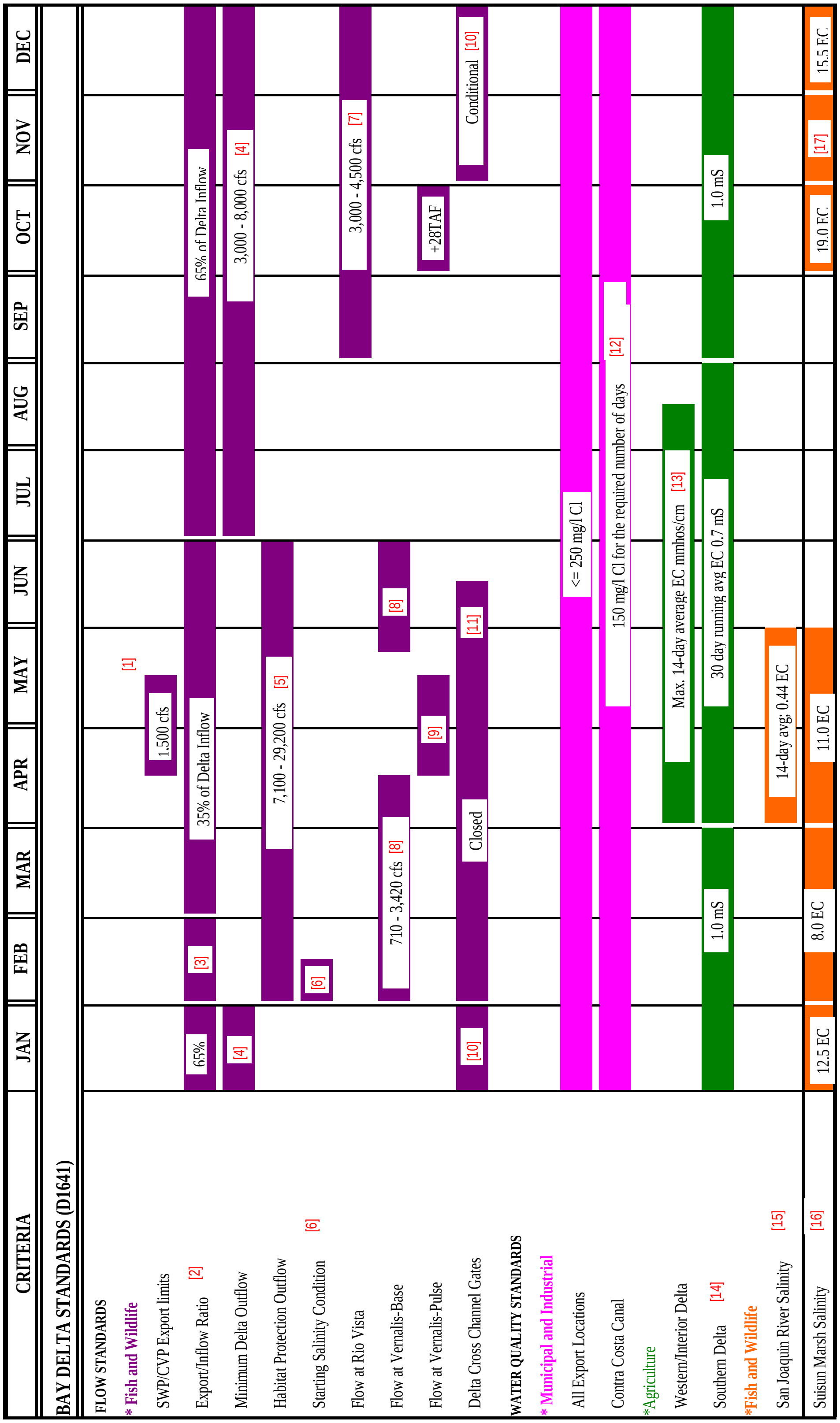


Figure 2.1: Water Quality Control Plan (D1641) Requirements

Footnotes for Figure 2.1 (1 of 2)

[1] Maximum 3-day running average of combined export rate (cfs) which includes Tracy Pumping Plant and Clifton Court Forebay Inflow less Byron-Bethany pumping.

Year Type	All
Apr 15 - May 15*	The greater of 1,500 or 100% of 3-day avg. Vernalis flow

* This time period may need to be adjusted to coincide with fish migration. Maximum export rate may be varied by CalFed Op's group.

[2] The maximum percentage of average Delta inflow (use 3-day average for balanced conditions with storage withdrawal, otherwise use 14-day average) diverted at Clifton Court Forebay (excluding Byron-Bethany pumping) and Tracy Pumping Plant using a 3-day average. (These percentages may be adjusted upward or downward depending on biological conditions, providing there is no net water cost).

[3] The maximum percent Delta inflow diverted for Feb may vary depending on the January 8RI

Jan 8RI	Feb exp. Limit
<= 1.0 MAF	45%
between 1.0 & 1.5MAF	35% - 45%
> 1.5 MAF	35%

[4] Minimum monthly avg. Delta outflow(cfs). If monthly standard <=5,000 cfs, then the 7-day avg. must be within 1,000 cfs of standard; if monthly standard > 5,000 cfs, then the 7-day avg. must be >= 80% of standard.

Year Type	All	W	AN	BN	D	C
Jan	4,500*					
Jul		8,000	8,000	6,500	5,000	4,000
Aug		4,000	4,000	4,000	3,500	3,000
Sep	3,000					
Oct		4,000	4,000	4,000	4,000	3,000
Nov-Dec		4,500	4,500	4,500	4,500	3,500

* Increase to 6,000 if the Dec 8RI is greater than 800 TAF.

[5] Minimum 3-day running avg. of daily Delta outflow of 7,100 cfs OR:either the daily avg or 14-day running average EC at Collinsville is less than 2.64 mmhos/cm (This standard for March may be relaxed if the Feb 8RI is less than 500 TAF. The standard does not apply in May and June if the May estimate of the SRI is < 8.1 MAF at the 90% exceedence level in which case a minimum 14-day running avg flow of 4,000 cfs is required).

[6] February starting salinity: if Jan 8RI >900 TAF, then the daily or 14-day running avg EC @ Collinsville must be <=2.64 mmhos/cm for at least one day between Feb 1-14. If Jan 8RI is between 650 TAF and 900 TAF, then the CalFed Op's group will determine if this requirement must be met.

[7] Rio Vista minimum monthly avg flow rate in cfs (the 7-day running avg shall not be less than 1,000 below the monthly objective).

Year Type	All	W	AN	BN	D	C
Sep	3,000					
Oct		4,000	4,000	4,000	4,000	3,000
Nov-Dec		4,500	4,500	4,500	4,500	3,500

[8] Base Vernalis minimum monthly avg flow rate in cfs (the 7-day running avg shall not be less than 20% below the objective). Take the higher objective if X2 is required to be west of Chipps Island.

Year Type	All	W	AN	BN	D	C
Feb-Apr14 & May16-Jun		2,130 or 3,420	2,130 or 3,420	1,420 or 2,280	1,420 or 2,280	710 or 1,140

Footnotes for Figure 2.1 (2 of 2)

[9] Pulse Vernalis minimum monthly average flow rate in cfs. Take the higher objective if X2 is required to be west of Chipps Island.

Year Type	All	W	AN	BN	D	C
Apr15 - May15		7,330 or 8,620	5,730 or 7,020	4,620 or 5,480	4,020 or 4,880	3,110 or 3,540
Oct	1,000*					

* Up to an additional 28 TAF pulse/attraction flow to bring flows up to a monthly average of 2,000 cfs except for a critical year following a critical year. Time period based on real-time monitoring and determined by CalFed Op's group.

[10] For the Nov-Jan period, Delta Cross Channel gates may be closed for up to a total of 45 days.

[11] For May21-Jun15, close Delta Cross Channel gates for a total of 14 days per CALFED Op's group. During the period the Delta Cross channel gates may close 4 consecutive days each week, excluding weekends.

[12] Minimum # of days that the mean daily chlorides <= 150mg/l must be provided in intervals of not less than 2 weeks duration. Standard applies at Contra Costa Canal Intake or Antioch Water Works intake.

Year Type	W	AN	BN	D	C
# Days	240	190	175	165	155

[13] The maximum 14-day running average of mean daily EC (mmhos/cm) depends on water year type.

Year Type	WESTERN DELTA				INTERIOR DELTA			
	Sac River @ Emmaton		SJR @ Jersey Point		Mokelumne R@Terminous		SJR @ San Andreas	
	0.45 EC from April 1 to date shown	EC value from date shown to Aug 15*	0.45 EC from April 1 to date shown	EC value from date shown to Aug 15*	0.45 EC from April 1 to date shown	EC value from date shown to Aug 15*	0.45 EC from April 1 to date shown	EC value from date shown to Aug 15*
W	Aug 15		Aug 15		Aug 15		Aug 15	
AN	Jul 01	0.63	Aug 15		Aug 15		Aug 15	
BN	Jun 20	1.14	Jun 20	0.74	Aug 15		Aug 15	
D	Jun 15	1.67	Jun 15	1.35	Aug 15		Jun 25	0.58
C		2.78		2.20		0.54		0.87

* When no date is shown, EC limit continues from April 1

[14] As per D-1641, for San Joaquin River at Vernalis, however, the April through August maximum 30-day running avg EC for San Joaquin River at Brandt Bridge, Old River near Middle River, and Old River at Tracy Road Bridge shall be 1.0 EC until April 1, 2005 when the value will be 0.7 EC.

[15] Compliance will be determined between Jersey Point & Prisoners Point. Does not apply in critical years or in May when the May 90% forecast of SRI <=8.1 MAF.

[16] During deficiency period, the maximum monthly average mhtEC at Western Suisun Marsh stations as per SMPA is:

Month	mhtEC
Oct	19.00
Nov	16.50
Dec-Mar	15.60
Apr	14.00
May	12.50

2.3.2 CVP/SWP Coordinated Operations Agreement (COA)

Under the Coordinated Operations Agreement (COA), the CVP and SWP are required to assure that each project obtains its share of water from the Delta and bears its share of obligations to protect other beneficial uses in the Delta and the Sacramento Valley. The Projects share water based on agreed upon percentages during balanced or excess flow conditions in the Delta. Banks Pumping Plant wheels water for the CVP when there is excess capacity at Banks Pumping Plant. The In-Delta Storage Project can assist in storing storage withdrawals of CVP water for wheeling by Banks Pumping Plant into CVP San Luis Reservoir. COA can also help in transferring EWA water. EWA water temporarily stored in In-Delta Storage reservoirs will be transferred by Banks Pumping Plant to the EWA storage account in San Luis Reservoir. In all, the coordinated operation of CVP and SWP facilities would significantly increase the use of stored water.

2.3.3 Joint Points of Diversion

Coordinated CVP/SWP operations include “joint points of diversion and use” to allow water pumped by either project to be used by both users. Before facilities are shared under the Joint Points of Diversion agreement, the project sharing its facilities must first meet its own project obligations.

2.4 Operational Criteria for the In-Delta Storage Project

The In-Delta Storage Project is considered to be a component of the SWP and CVP system for the purpose of these analyses. In addition to D1641, COA operations, and Joint Points of Diversion, criteria for In-Delta Storage Project operations include SWRCB Water Right Decision 1643 needs/requirements (including biological opinions and CUWA Water Quality Management Plan requirements).

2.4.1 SWRCB Water Right Decision 1643 Requirements

The SWRCB Decision 1643 conditionally approved the Delta Wetlands Properties water right application to appropriate water by direct diversion and storage on Webb Tract and on Bacon Island. A detailed set of constraints that the project must satisfy is given in the DWR Draft Report on Operations, December 2003. Other storage projects being studied for the Bay-Delta Program have not yet progressed far enough in the process to have their own assigned operational requirements similar to D1643 for In-Delta Storage. The operation criteria of the In-Delta Storage Project, which is considered as a joint State and federal project, may change and final requirements would be established through SWRCB review of the DW Permit after the subsequent EIR/EIS process is complete. The DW permit requirements are shown in Figure 3.2 and the main provisions are summarized as follows.

- Allowable diversion to storage could only occur when all Delta outflow requirements are met.
- Initial diversions to the DW Project shall not be made for the current water year (commencing October 1) until salinity (X2) has been west of Chipps Island (75 km upstream of the Golden Gate Bridge) for a period of ten (10) consecutive days. There are additional restrictions on diversions during other times of the year based on X2 position.

- Maximum rate of diversion onto either Webb Tract or Bacon Island would be 4,500 cfs (9 taf/day). The combined maximum daily average rate of diversion for all islands (including diversions to habitat islands) will not exceed 9,000 cfs.
- The total amount of water taken from all sources shall not exceed 822 taf per water year (October 1 to September 30). Also, maximum annual release of stored water would be 822 taf.
- The amount of water that can be diverted depends on fisheries restrictions as well as WQMP surplus and Delta Outflow constraints.
- Maximum Annual export of stored water would be 250 taf. No releases shall be made for export from Webb Tract from January through June.
- DW Project releases are subject to monthly Export/Inflow ratio constraints except when water is discharged for the environmental water account.

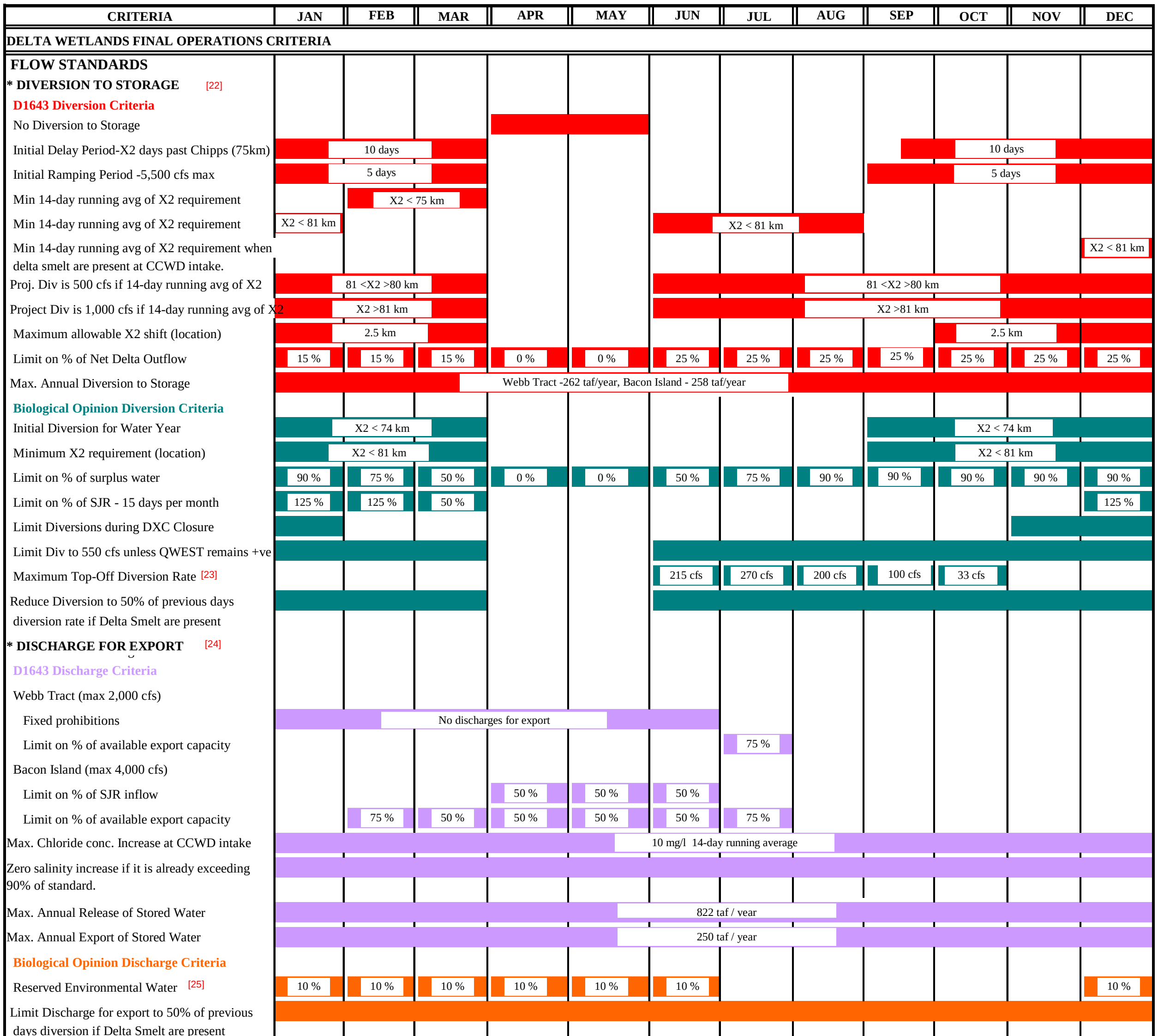
2.4.2 CVPIA

In-Delta Storage could provide water in addition to Level 2 refuge supply to meet Level 4 refuge demand and thus releases could be made to benefit CVPIA. It would protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley with additional water supply for refuges. This CVPIA use could also be considered as system-wide use and could assist in meeting the following CVPIA objectives:

- improve the operational flexibility of the CVP; and
- achieve a reasonable balance among competing demands for use of CVP water, including the requirements of fish and wildlife, agriculture, municipal and industrial, and power contractors.

2.4.3 Groundwater and Surface Water Conjunctive Use

The In-Delta Storage Project could provide additional water for recharge to help control groundwater overdraft south of the Delta. and also improve water supply reliability by in-lieu transfers of water for the other state-wide urban and agricultural users. Further details of conjunctive use operations are given in December 2003 Draft Report on Operations.



Footnotes

[22] Maximum rate of diversion onto either Webb Tract or Bacon Island would be 4,500 cfs. The combined maximum daily average rate of diversion for all islands (including 200 cfs diversions to each of the habitat islands) will not exceed 9,000 cfs.

[23] Water will be diverted onto Bacon Island and Webb Tract from June through October in order to offset actual reservoir losses of water stored on those islands, referred to as topping-off reservoirs. The maximum topping-off diversion rates shall be reduced by an amount equal to the habitat island diversions during the same period.

[24] Discharges will be pumped at a combined maximum daily average rate of 6,000 cfs (4,000 cfs from Bacon Island and 2,000 cfs from Webb Tract). Discharge is subjected to export limits, treated as an export in the monthly E/I ratio computation except when water is discharged for environmental water account.

[25] A quantity of "environmental water" will be provided for release as additional Delta outflow equal to 10% of all discharges for export that occur in the period of December thru June.

Figure 2.2: D1643 Constraints in the Delta Wetlands Properties Permit

Chapter 3: Modeling Approach

3.1 CALSIM and DSM2 Planning Models

California Simulation Model (CALSIM) is a generalized water resource planning tool developed jointly by the Department of Water Resources (DWR) and the U.S. Bureau of Reclamation Mid-Pacific Region (Reclamation). CALSIM II is the application of the CALSIM software to model the State Water Project (SWP), the federal Central Valley Project (CVP) and areas tributary to the Sacramento-San Joaquin Delta (Delta). The primary purpose of the CALSIM II model is to evaluate the performance of the CVP and SWP systems, 1) at current or future levels of development, 2) with and without various assumed future facilities and, 3) with different modes of facilities operations. Comparative analysis of model results can be used to assess the water supply impacts of any proposed expansion of project facilities, changes in regulatory requirements, changes in operating criteria, or many other “what-if” scenarios.

The Delta Simulation Model-2 (DSM2) is a hydrodynamic and water quality model that simulates the flow patterns, and water quality (salinity and/or other constituents) in the Delta region. Thus the CALSIM II and DSM2 models jointly allow the planners to examine the flow, stage and water quality conditions of the Delta with and without proposed facilities.

3.2 Monthly CALSIM Model

CALSIM II simulates operation of the SWP/CVP system for a 73-year period, from WY1922 through WY1994, using a monthly time-step. The model assumes that facilities, land use, water supply contracts and regulatory requirements are constant over this period, representing a fixed level of development (e.g. 2001, 2020 or 2030). The historical flow record October 1921 – September 1994, adjusted for the influence of land use change and upstream flow regulation, is used to represent the possible range of water supply conditions.

A SWP and CVP, and south of Delta delivery logic uses runoff forecast information and uncertainty. Similarly, delivery versus carryover risk curve and standardized rules (Water Supply Index versus Demand Index Curve) are used to estimate the total water available for delivery and carryover storage. The logic updates delivery levels on monthly scales, from January 1 through May 1, as water supply parameters become more certain.

To estimate the DSM2 model generated salinity at key locations in the Delta, an algorithm that trains its parameter using Artificial Neural Network (ANN) routine, has been used. The ANN flow-salinity module predicts electrical conductivity at Old River at Rock Slough, San Joaquin River at Jersey Point, and Sacramento River at Emmaton. Salinity is estimated based upon time history the Sacramento River inflow, San Joaquin River inflow, DCC gate position, and several Delta export and diversion variables. The Sacramento River inflow term combines the flows from Sacramento River at Freeport, Yolo Bypass, Mokelumne, Cosumnes, and Calaveras Rivers. DCC gate position is assumed to be fully open or closed. Delta exports and diversions include SWP exports at Banks Pumping Plant and North Bay Aqueduct, CVP exports at Tracy, Contra Costa Water District diversions, and net channel depletions. A total of 148 days of values of each of these parameters are included in the correlation, representing an estimate of the length of water quality "memory" in the Delta.

For a more detailed description of CALSIM II modeling assumptions and procedures the reader is referred to the CALSIM II Benchmark Studies report, dated September 30, 2002, and the Historical Simulation Report, dated November 12, 2003. Both reports are available from the DWR modeling home page (http://modeling.water.ca.gov).

3.2.1 Limitations of Monthly CALSIM Model

All models have limitations. CALSIM II is primarily a mass balance accounting model. Results are dependent upon the quality of the inflow hydrology and the estimated demands. Results also depend on the model operational logic and assigned priorities. Operational decisions must be formalized into mathematical algorithms even when they are in reality subjective in nature. Other limitations are imposed by the spatial and temporal resolution of the model.

In the monthly CALSIM model many large areas are aggregated to simplify the model operation. This aggregation is generally considered satisfactory for large projects. However, when evaluating the yields from smaller projects, increases in the level of detail of hydrologic inputs may be required. Aggregation in time and space omits several details of the projects, such as the quick response provided by the In-Delta Storage facilities to the operations of the CVP and SWP. Thus, projects benefits could be under/over estimated.

3.3 Daily CALSIM Model Development

The In-Delta Storage facilities are located close to the CVP and SWP export facilities and other key locations in the Delta and can respond quickly to the Project's needs. To account for this quick response time, the In-Delta Storage facilities operations (diversions and release rules) required a model that runs on a daily time-step. Thus, a daily time-step Delta Model was created for conducting In-Delta Storage Project studies. This model was used in conjunction with the CALSIM II monthly model. The entire system's operation was simulated for a one month period with the CALSIM monthly model and then the information on inflows to the Delta and south-of-Delta delivery amounts were passed on to the Daily Delta Model. The Daily Delta Model was used to re-simulate the operations in the Delta and the export facilities.

The monthly CALSIM II model provides monthly flows for various Delta locations. However, the daily model requires daily flow data as its input. Thus, a disaggregating model, which was trained using historical observations, was used to generate the daily flows from the monthly flows. While the daily inflow hydrograph was patterned after the historically recorded inflow, the total volume of the inflow to the Delta provided by the monthly model was preserved.

The results of the Daily Delta Model are provided to the monthly model as the initial conditions for the following month's simulation. The operation of the upstream reservoirs is re-simulated, and any gains or losses of water are reflected in Delta outflow and storage at San Luis Reservoir. The next month's simulation is then started with the modified end-of-month storage in San Luis Reservoir and the state of the Delta as simulated by the Daily Delta Model.

The determination of the allowable exports as a function of the salinity standards at various locations in the Delta is accomplished by providing the daily model with the monthly model's ANN estimation of the cap on total exports imposed by the controlling salinity station. This cap on the total exports is observed every day in the current month's simulation by the daily model and the project exports never exceed this maximum allowable rate.

In-Delta Storage Project yield is maximized by adding the storage in the In-Delta Storage facilities to the SWP portion of San Luis Reservoir by as much vacant space as is available in SWP San Luis Reservoir before making a computation of the Water Supply Index (WSI). The remaining portion of the storage in the In-Delta Facilities (after subtraction of the vacant space in SWP San Luis Reservoir) is added directly to the SWP delivery target.

To achieve the most efficient operation of the two water supply storage facilities in the with-project simulation run, the priority of filling is given to Bacon Island. This is done because an extended period of allowable discharge from Bacon Island allows for potential withdrawal and subsequent filling in the same year more readily, whereas the limited allowable period for discharge from Webb Tract makes multiple fillings in the same year practically impossible. The priority of filling in Bacon Island is achieved by assigning a higher reward for diverting the available water into the conservation storage of Bacon Island as compared to that of Webb Tract.

3.4 Reiterations with DSM2 Model

CALSIM provides an optimal set of operational decisions for a given time period under the given set of constraints. Using the CALSIM run as input, a base DSM2 run is made to check for water quality violations, particularly DOC at key locations in the Delta. The DOC from the DSM2 is analyzed and a DOC dispersion mechanism is developed for island discharges using the Particle Tracking Model. This new algorithm is implemented in CALSIM to get a more realistic model to assess the impacts of DOC constraints in the urban intakes. With the new inputs, a CALSIM run is made and the results are analyzed by DSM2. The iterations continue until the DSM2 model shows no violations in the DOC water quality at key export locations.

3.5 Interface with DYRESM Model

The numerical model, DYRESM-WQ (Dynamic Reservoir Model – Water Quality) is a one dimensional model that predicts temperature, salinity, and water quality in a reservoir by integrating a process based physical model with a biochemical model. DYRESM-WQ uses diversion and release information from CALSIM as input.

The DYRSEM-WQ model is used to study the stratification of the reservoir and to predict the temperature differentials between the reservoir islands and the receiving channels. The model is also used to determine the changes in channel water temperature for the CALSIM and DSM2 model operation scenarios. Calibration and validation of the DYRSEM were not possible because of the project island reservoir does not exist. Thus, calibration of the model was planned using an analogous reservoir system. Wind speed measured in the Delta is used as model input, and sensitivity analyses are conducted by evaluating the impacts of the lower wind speeds. In the present study, the DYRSEM-WQ model is run for three representative years.

3.6 Interface with Economic Models

Economic models will be used to evaluate the economic justifications for the proposed In-Delta Storage Project. Additionally, a project area economic impact analysis will be made to disclose the potential for both positive and negative impacts to the economy of the local area. While the former analysis is traditionally done using only direct costs and benefits, the latter considers indirect and induced local economic effects—the “ripple” effects.

The delivery information from the CALSIM model and stage and flow information from DSM2 model will be used as input in the economic models. The operation rules could be used to estimate the project costs that include the following items.

- Levee maintenance
- Intake and Outlet structures maintenance including pumping stations, gate units, and fish screens for both, reservoir and habitat islands.
- Pumping energy costs
- Seepage control systems maintenance and monitoring
- Water quality monitoring, and
- Environmental monitoring including wildlife and habitat monitoring.

The model output could be used to calculate the project benefits that include the following.

- Additional SWP/CVP system exports for urban and agricultural uses
- Delta Ecosystem needs including Delta WQCP requirements, fisheries and aquatic habitat needs and water quality flow requirements
- Contribution to meet CVPIA requirements including South of Delta Refuges
- Additional Joint Point Diversion Benefits
- Environmental Water Account
- Banking for Water Transfers and carryover storage.
- Recreational Benefits

Chapter 4: Operational Scenarios

4.1 Introduction

The operational scenarios developed for this feasibility study are samples of how the In-Delta Storage Project could be operated; however, many operational scenarios are possible. The sample operational scenarios completed for this study were designed to meet a range of objectives, including water supply reliability improvement, EWA goals and environmental enhancement.

To begin with, a No-Action Base study (Study 1) was developed and three sample operational scenarios (Studies 2, 3 and 4) were developed, which include the In-Delta Storage Project facilities with varying operations, such as the inclusion of EWA and ERP.

Once the three sample operational scenarios were completed and evaluated, six subsequent impact evaluation studies were developed. All six impact evaluation studies are based on Study 4, as this scenario included all three evaluations (water supply, EWA and ERP). These studies were designed to analyze the impacts of applying DOC constraints, dilution of DOC through circulation, fisheries extreme conditions, climate change, coordinated operation with expanded Los Vaqueros Reservoir, and SWRCB D1643. A list of the operational scenarios analyzed in this report is shown in Table 4.1. Detailed assumptions for the future

Table 4.1: Operational Scenarios

No-Action Base and Sample Operational Scenarios [1]
Study 1: No-Action Base (Future without project under D1641)
Study 2: Water Supply (Project with D1641 & D1643)
Study 3: Water Supply / EWA (Project with D1641 / D1643 and EWA)
Study 4: Water Supply / EWA / ERP (Project with D1641 / D1643 / EWA and ERP)

Impact Evaluation Studies [2]
Study 4a: Initial Project Conditions w/ DOC Constraints Applied (Study 4 with DOC Constraints)
Study 4b: DOC Dilution through Circulation (Study 4 with DOC Constraints and Circulation)
Study 4c: Fish and Aquatic Habitat Protections during Drought and Extreme Conditions (Study 4 with FMWT<239)
Study 4d: Climate Change Impact (Study 4 with updated hydrology)
Study 4e: Coordination with Los Vaqueros Expanded Reservoir (Study 4 with LV Operation)
Study 4f: Impact of D1643 on In-Delta Storage Operations (Study 4 without D1643)

[1] DOC constraints are not applied to these studies

[2] Study 4b included two runs (200 cfs and 400 cfs max circulation)

* All studies coordinate operations of In-Delta Storage with SWP/CVP operations

No-Action Base study and "with project" sample operational scenarios are summarized in Appendix B, Table B.1. Appendix A provides a list of study details for all operational scenarios. Summary level results for all operational studies are presented along with the study descriptions below, and more detailed analyses are presented in Chapter 5.

4.2 Base Operational Scenario

4.2.1 Study 1: No-Action Base

The No-Action Base, Study 1, represents the existing SWP and CVP systems, without the In-Delta Storage facilities in place, for the 2020 level of development and hydrology. This scenario provides a basis for comparing project performance of other "with project" scenarios. Operating rules specified in the D1641 benchmark study, with changes related to the Revised Fish Alternative are used in the No-Action Base study. The Revised Fish Alternative is being considered as the preferred baseline in the South Delta Improvements Program EIR. The Revised Fish Alternative makes two modifications to the D1641 benchmark study. The first modification includes a revision to the Banks Pumping Plant permitted capacity (8,500 cfs Oct-Mar 15, 6,680 cfs Mar 15-Jun 30, 8,000 cfs Jul, Aug & Sept) for export operations. The second modification considers and a joint point of diversion for wheeling of CVP water through Banks Pumping Plant. This study also includes coordinated SWP/CVP operations under COA.

To evaluate the benefits of In-Delta Storage in the CVP and SWP systems, the "with project" operational scenarios were compared with the No-Action Base conditions, so the benefits computed for all "with project" scenarios are relative to the No-Action Base. Results of the No-Action Base study for the 73-year period are given in Table 4.1.

4.3 Sample Operational Scenarios

As mentioned above, three sample operational scenarios (Studies 2, 3 and 4) were developed to meet a range of objectives, including water supply reliability improvement, water quality improvement and environmental enhancement. Studies 2, 3 and 4 include In-Delta Storage Project facilities with varying operations. All three operational scenarios include the following:

- Coordinated operations of the In-Delta Storage Project with CVP/SWP operations under SWRCB May 1995 WQCP, Water Right Decision 1641, Water Right Decision 1643, CUWA Water Quality Management Plan (with the exception of Organic Carbon constraints), and Biological Opinions
- CVPIA level 4 refuge demands in addition to level 2 refuges; and
- Groundwater surface water conjunctive use

Studies 2, 3, and 4 do not include the DOC, salinity, DO and temperature constraints specified in D1643 and the Water Quality Management Plan. However, the DOC issue is addressed in the impact evaluation studies 4a and 4b. As no specific releases were made for improvements to salinity, DO and temperature and emphasis of water quality studies was on meeting D1643 and WQMP standards, DSM2 was used to evaluate if changes in these parameters were within the specified standards. Detailed information on DSM2 applications is given in Chapter 4 on Water Quality Investigations.

The operation scenarios were evaluated and compared with the No-Action Base conditions to assess benefits provided by the In-Delta Storage Project when operated in coordination with the SWP/CVP system. A summary of 73-year study results, including information on diversions and discharges from the In-Delta Storage islands, is given in Table 4.1.

4.3.1 Study 2: Water Supply Study

The objective of Study 2 is for the In-Delta Storage Project to help meet the future demands of CVP/SWP water contractors when supplies are short. The project could produce additional water deliveries to urban and agricultural water users (modeled as SWP/CVP, but could be any urban or agricultural water user). SWP and CVP allocated deliveries as of May 1 were given the first priority to be met by direct supplies to SWP and CVP users as in the Base study. The additional refuge supply and conjunctive use supply were made available only when export capacity was available. The estimated annual water supply benefits vary from 61.3 taf during the dry period (assumed as average of 1928-34, 76-77 and 87-92 dry periods), to 123.9 taf long-term average (73 year average from 1922-94).

4.3.2 Study 3: Water Supply Study with EWA

The objective of Study 3 is twofold: to help meet the future demands of CVP/SWP water contractors and to provide operational flexibility for the Environmental Water Account (EWA). Study 3 builds upon Study 2 by adding EWA as another buyer of In-Delta water. The EWA gives fishery agencies and state water managers increased flexibility to alter pumping and delivery schedules to protect fish without affecting water supply reliability.

In this study, no EWA actions (cuts in exports) are modeled. It is assumed the EWA takes fish protection actions, and, therefore, the EWA will have demand for In-Delta water when it and Banks export capacity are available. EWA buys the water to pay the projects back for the assumed fish protection actions. It was assumed that any water that was not needed by SWP and CVP as of May 1 could be purchased for EWA. EWA is given a lower priority to the water than the refuges and groundwater conjunctive use, but from July through September Banks permitted capacity is increased from 8000 cfs to 8500 cfs with the extra 500 cfs dedicated to moving In-Delta water for the EWA. This guarantees that, while low in priority, the EWA can purchase a significant share of the unwanted In-Delta water because it can move water that the refuges and groundwater recharge are otherwise unable to. The 500 cfs increase in permitted capacity for EWA use is part of the proposed Revised Fish Alternative of the South Delta Improvement Program.

As shown in Table 4.1, direct SWP/CVP deliveries decrease from 124 taf to 98 taf as EWA uses 31 taf of In-Delta Storage water. Total annual supply benefit is 129 taf.

4.3.3 Study 4: Water Supply Study with EWA and ERP

The objective of Study 4 is threefold: to help meet the future demands of CVP/SWP water contractors, to provide operational flexibility for the Environmental Water Account (EWA), and to provide additional water to help meet the Ecosystem Restoration Program (ERP) goals.

An Environmental Restoration Program (ERP) demand for increased Delta outflow in March, April and May is added to Study 3 to create Study 4. In this scenario, the ERP Delta outflow targets are 20,000, 30,000 and 40,000 cfs for an additional 10 days in March and 10 days in April/May for Dry, Below Normal and Above Normal water year types, respectively. The water year types are based on the Sacramento Valley Water Year Hydrologic Classification. The order of priority given is; SWP, CVP, refuge, groundwater conjunctive use, EWA, and ERP demand for In-Delta water.

The ERP was established to accomplish strategic program goals through habitat creation and management and the EWA was created to reach these goals through flow manipulations. Some of the implementing agencies for the EWA (USFWS, NOAA Fisheries and CDFG) are also the ERP implementing agencies. These agencies are responsible for exercising biological judgment to determine SWP/CVP operational changes to protect and enhance at-risk fish species dependent on the Delta. All of the at-risk fish species that are targeted for enhancement and recovery by the EWA are also targeted for recovery by the ERP, so there is a direct linkage between the goals of these two programs. As shown in Table 3.1, total annual supply change is 136 taf with 83 taf going to projects, 37 for EWA use and 16 taf for additional ERP Delta flow.

4.4 Impact Evaluation Studies

Many factors can affect the operation of the In-Delta Storage Project, but it is difficult to assess the combined impacts of multiple conditions at the same time. With that said, a number of impact evaluation studies were developed and analyzed to determine the potential impacts of various conditions on the project.

The impact evaluation studies were designed to compare the trade-offs that are possible when specific water management actions are applied to the In-Delta Storage Project. These studies are all iterations of Study 4 (water supply, EWA and ERP) with various changes to gage the potential impact of operational constraints and modeling assumptions that were not addressed in Studies 2, 3, and 4. These include the D1643 DOC standards, fish protections in extreme conditions (FMWT < 239), climate change, and changes in infrastructure such as an expanded Los Vaqueros Reservoir and increase Contra Costa export capacity. Also, the impacts of D1643 on the island reservoirs' ability to divert and deliver water were evaluated by running an In-Delta storage operation unencumbered by this decision.

The impact evaluation studies were evaluated and compared with Study 4 to assess the impact of various operational constraints and modeling assumptions placed on the In-Delta Storage Project. A summary of 73-year study results, including information on diversions and discharges from the In-Delta Storage islands, is given in Table 4.2.

4.4.1 Study 4a: Initial Project Conditions with DOC Constraints Applied

The objective of Study 4a is to model the In-Delta Storage Project with dissolved organic carbon (DOC) constraints applied, as specified in the WQMP. Study 4a builds upon Study 4 by adding DOC constraints to the In-Delta Storage Project to determine the impact on In-Delta Storage Project yield. For more details on the implementation of the constraints, see Appendix A of the December 2003, Draft Report on Operations.

When added to the CVP/SWP systems, the In-Delta Storage Project will impact water quality in the Delta. The DOC of the water channel sources (Sacramento River and San Joaquin River) coming into the reservoir is known from historical field measurements. When water is stored over peat soils, DOC growth occurs as indicated by field investigations and laboratory experiments. DOC is an important water quality issue to be resolved for project operations.

As constraints dictated by D1643 are to be applied, base water quality conditions are needed. The DOC data generated by DSM2 using Study 1 (No-Action Base) operational input covers the period from October 1975 to September 1991. To generate a 73-year data set of DOC concentrations, the 16 year DSM2 data was sorted by water year type (Sacramento Valley Water Year Hydrologic Classification) and daily averages for each location were computed. These daily average DOC time series were then applied to the remainder of the 73-years based on water year type. As given in Table 4.2, the average annual impact of DOC constraints on project yield is 20 taf in comparison to Study 4.

4.4.2 Study 4b: DOC Dilution through Circulation

The objective of Study 4b is to determine water circulation needs so that island reservoirs can be operated within the required DOC standards without impacting project yield. Study 4b is similar to Study 4a; however, an amount of 200 to 500 cfs will be circulated between each reservoir and the adjacent sloughs whenever favorable conditions exist between the reservoir and slough.
The amount of circulation is controlled by the following criteria:

- Releases from In-Delta Storage reservoirs shall cease if they cause total organic carbon (TOC) concentrations at the urban intakes (SWP, CVP and CCWD pumping plants), and at a receiving water treatment plant, to exceed 4.0 mg/L. Storage releases or circulation may resume once the DOC concentration is below the set standard.

- Releases from In-Delta Storage reservoirs shall cease if they cause total organic carbon (TOC) concentrations at the urban intakes (SWP, CVP and CCWD pumping plants) to increase by more than 1.0 mg/L. TOC concentrations shall be calculated as a 14-day average. Storage releases or circulation may resume once the 14-day average DOC concentration is below the set standard.

Circulation is a mechanism to discharge DOC from the reservoirs when there is not an opportunity to discharge for export or Delta outflow. During circulation, island diversions equal island discharge resulting in no net change to the Delta water balance. Depending on stage in the reservoirs and channels, water will be pumped in one direction and gravitational flow will occur in the other. Diversions are assumed to occur on the south side of each island and discharge on the north. The DOC concentration of the circulation diversion is equal to the base DOC concentration in the channel whereas the DOC concentration of the discharge is assumed to equal the island storage DOC concentration calculated at the beginning of the day. Complete mixing is assumed to occur at the end of the day. It is assumed that circulation has no impact on DOC production in the reservoirs. While the mass of DOC discharged from the islands with circulation increases with the mass of DOC diverted by circulation, the concentration of discharge is diluted as is its impact to DOC concentrations at the urban intakes. By reducing the DOC concentration on the islands, IDS can then take better advantage of opportunities for storage release when they arise.

Transport of DOC to the urban intakes is modeled with linear regression equations generated with a DSM2 fingerprint analysis. See the Water Quality Investigations report for further details.

Project diversions and discharges from this CALSIM study were used as input to DSM2 to determine changes to TOC values at the urban intakes and information is presented in Chapter 4 on Water Quality. As given in Table 4.2, circulation will reduce the annual impact of applying DOC constraints by 6 taf to 10 taf for 200 to 500 cfs circulation.

4.4.3 Study 4c: Fish and Aquatic Habitat Protections during Drought and Extreme Conditions

The objective of Study 4c is to determine the amount of water needed to meet requirements when the Fall Midwater Trawl Abundance Index for delta smelt (FMWT) is less than 239. The FMWT Index is an indicator for determining the abundance of delta smelt within the Delta and a FMWT Index of less than 239 indicates a significant decline in delta smelt abundance.

According to an excerpt from the Department of Fish and Game web site, “The delta smelt population is affected by the amount of outflow from the Estuary which varies from year to year due to precipitation and water management. A positive significant relationship between the fall midwater trawl abundance index and the number of days the entrapment zone (where salt and fresh water meet) is in Suisun Bay from February through June has been observed. This suggests that the delta smelt population does better when outflow is allowed to flow downstream and create nursery habitat for delta smelt in Suisun Bay”.

The following procedure was used to determine the water supply impact when the FMWT Index is less than 239 during drought or extreme dry conditions:

- Study 4 was run assuming a FMWT Index of less than 239 in all 73 years. According to the constraints imposed by D1643, no diversions for storage will be made from February 15 through June 30 if FMWT is less than 239. This will negatively impact project yield.
- Assume that the FMWT Index is less than 239 during 28-percent of the 73-year study period (FMWT Index was less than 239 in 8 of 28 years from 1967 to 1994, which is 28 percent). Assume that the FMWT Index is greater than 239 during the remaining 72-percent of the 73-year study period.

- Assume the FMWT index is independent of hydrology and operations and use the formula below to calculate a weighted project yield for Study 4c.

$$ProjectYield_{Study4c} = \left[\left(ProjectYield_{\substack{Study4 \\ FMWT>239}} \times 0.72 \right) + \left(ProjectYield_{\substack{Study4 \\ FMWT<239}} \times 0.28 \right) \right]$$

The weighted project yield (Table 4.2) with FMWT impact is 20 taf less due to the assumption that extreme conditions constraint has to be met. The assumption that the FMWT index is independent of hydrology is likely conservative. If, as the Department of Fish and Game suggests, there is a positive correlation between the FMWT index being less than 239 and drought conditions, the negative impact of the FMWT index conditional constraints in D1643 will be less than reported. Due to other constraints on island operations, IDS rarely diverts water during drought conditions which is at the same time that the FMWT index is most likely to be low. Obviously, zero diversions can not be decreased.

4.4.4 Study 4d: Climate Change Impact

The objective of Study 4d is to assess the impacts climate change may have on the In-Delta Storage Project yield. Because of the project's location, In-Delta Storage would capture early spring flows and store additional water that may end up in the Bay. Study 4d uses a different hydrology than study 4. The hydrology used in Study 4d is modified to reflect changes in the climate in the region due to global warming. To accurately compare the results of this study, a modified No-Action Base study (Study 1d) that uses the same modified hydrology as Study 4d was created by shifting inflows into the Delta from spring (March, April or May flows) to winter flows (January or February). Results of this study are compared with the No-Action Base (Study 1) and are shown in Table 4.2. The results indicate that the project yield will marginally change over time. For example, this study shows an average annual delivery of 139 taf in comparison to 136 taf for Study 4 without climate change. Also, there would be additional 11 taf of carryover storage in Oroville Reservoir.

4.4.5 Study 4e: Coordination with Los Vaqueros Expanded Reservoir

The purpose of this study is to assess if there are additional benefits of considering In-Delta Storage operations in coordination with the Los Vaqueros Reservoir expansion. In addition, it was also the intent to see if this project is competing for the same surplus water. This project is at a different level of study development. The studies are very preliminary and no final operational plans have been developed. Focus of this study was on trend evaluation rather than importance of numbers. The current operational studies for operating an expanded Los Vaqueros Reservoir are appraisal level scenarios based on D1641 requirements with 2020 hydrology modeled using a monthly time step, whereas the In-Delta Storage Project has D1643 constraints applied and uses the CALSIM II modeling application on daily basis.

Diversion information for the Los Vaqueros Reservoir expansion was obtained from the ongoing planning studies. Los Vaqueros diversions assume a secondary use of the project after leaving a surplus flow buffer of 5,000 to 10,000 cfs that can be used by expanded Banks 8,500 cfs and future extensions in the SWP and CVP system such as In-Delta Storage. Results of this scenario are presented in Table 4.2. The study results indicate that the Los Vaqueros expansion will have minimal impact on In-Delta Storage operations.

4.4.6 Study 4f: Impact of D1643 on In-Delta Storage Operations

Study 4f was run to determine the impact of D1643 on potential In-Delta Storage Project yield. Studies 4, 4a, 4b, and 4c were run with different combinations of D1643 constraints. Therefore, Study 4f was run without D1643 constraints for the purposes of comparison. Two constraints were retained though:

1. No island diversions during April and May.
2. Islands can only divert a percentage of available surplus water as specified in D1643 (90% Aug-Jan; 50% Mar and Jun; 75% Feb and Jul; 0% Apr and May).

In fact, this study simulates the In-Delta Storage operations in coordination with SWP and CVP operations including Joint Points of Diversion for the period of WY 1922 – WY1994 using requirements close to D1641. Other storage projects being studied for the Bay-Delta Program have not yet progressed far enough in the process to have their own assigned operational requirements similar to D1643 for In-Delta Storage. This study would also serve as a comparison with other storage projects. Results given in Table 4.2 indicate that the impact of D1643 requirements on In-Delta Storage water balance is on the order of about 100 taf.

Table 4.1: Summary of Results for Sample Operational Scenarios

CALSIM-II Study No. Study Period Oct 1922-Sept 1994	Island Diversion (TAF)	Island Discharge (TAF)	Contribution to D1641 (TAF)	SWP/CVP Delivery (TAF)	Change in Water Supply (TAF)				Change in Oroville Carryover Storage (TAF)	In-Delta Storage Project Carryover Storage (TAF)
					SWP/CVP Delivery	EWA	ERP	Total Water Supply Change		
Study 1: No Action Base Case (D1641)	-	-	-	5774	-	-	-	-	2028	-
Study 2: Water Supply (Project with D1641 & D1643)	159	159	19	5898	124	-	-	124	+35	31
Study 3: Water Supply / EWA (D1641 /.D1643 and EWA)	165	165	19	5872	98	31	-	129	+36	11
Study 4: Water Supply / EWA / ERP (D1641 / D1643, EWA and ERP)	165	165	15	5857	83	37	16	136	+22	11

Table 4.2: Summary of Results for Impact Evaluation Scenarios

CALSIM-II Study No. Period Oct 1922-Sept 1994	Island Diversion (TAF)	Island Discharge (TAF)	Contribution to D1641 (TAF)	SWP/CVP Delivery (TAF)	Change in Water Supply (TAF)				Change in Oroville Carryover Storage (TAF)	In-Delta Storage Project Carryover Storage (TAF)
					SWP/ CVP Delivery	EWA	ERP	Total Water Supply Change		
Study 1: No Action Base Case (D1641)	-	-	-	5774	-	-	-	-	2028	-
Study 4: Water Supply / EWA / ERP (D1641 / D1643, EWA and ERP)	165	165	15	5857	83	37	16	136	+22	11
Study 4a: Initial Project Conditions with DOC Constraints Applied (Study 4 with DOC Constraints)	145	145	10	5861	87	15	14	116	+4	55
Study 4b_200: DOC Resolution through Circulation (Study 4 with DOC Constraints and 200cfs maximum Circulation)	147	147	12	5863	89	18	15	122	+9	45
Study 4b_500: DOC Dilution through Circulation (Study 4 with DOC Constraints and 500cfs maximum Circulation)	153	153	13	5866	92	20	14	126	+17	38
Study 4c: Fish and Aquatic Habitat Protections during Drought and Extreme Conditions (Study 4 with FMWT < 239)	143	143	13	5844	70	31	15	116	0	10
Study 1d: Base for Climate Change Impact Study (D1641 with updated hydrology)	-	-	-	5740	-	-	-	-	1790	-
Study 4d: Climate Change Impact (Study 4 with updated hydrology. Compared with Base Study 1d)	163	163	15	5832	92	33	14	139	+33	11
Study 4e: Coordination with Los Vaqueros Expanded Reservoir (Study 4 with expanded LV operation)	159	159	14	5853	79	36	14	129	+14	11
Study 4f: Impact of D1643 on In-Delta Storage Operations (Study 4 without D1643)	270	270	26	5896	122	44	14	180	+50	50

Chapter 5: Analysis of Operational Results

5.1 General

The In-Delta Storage Project can be operated in many ways and can provide multiple benefits by meeting water supply reliability, water quality, and environmental water needs.

This chapter presents modeling results and analyses for the No-Action Base study, the three sample operational scenarios, and the impact evaluation studies. A summary of results for all the modeling studies are given in Tables 4.1 and 4.2.

The analysis results presented in this chapter reflect both "long-term" averages and "dry period" averages. The long-term is defined as the 73-year period from October 1, 1921 to September 30, 1994, or water year 1922 through 1994. To represent the "dry period", an average of the following three hydrological periods was used:

- May 1928 to October 1934
- October 1976 to September 1977
- October 1987 to September 1992

Three years: 1979, 1986, and 1987/1985 were selected for conducting detailed analyses of operational studies. These years represent below normal, wet and dry conditions, respectively, covering a range of hydrologic conditions.

5.2 Typical Project Operations under Study 4

In-Delta Storage Project operations are affected by many factors and vary under different operational scenarios. To give the reader a sense for how the project can be operated, results from Study 4 (Water Supply/EWA/ERP study) are presented below.

Diversions: As shown in Figure 5.1, most diversions to In-Delta Storage typically occur during the months of December, January, February and June over the long-term. Some diversions also occur during the summer and late fall months. Figure 5.2 shows that during the dry period diversions are only made during January, February and June, with very little diversions occurring in July. Figures 5.1 and 5.2 also show the contribution of total diversions going to Webb Tract and Bacon Island. These figures present average monthly values, so the extremes are not apparent.

Releases: As shown in Figure 5.3, releases from In-Delta Storage typically occur during the spring and early summer months over the long-term period with the majority of releases occurring in July. The magnitude of releases that occur February through June are similar for the long-term and dry periods; however, releases during January are more and during July are significantly less during the dry period. Figures 5.3 and 5.4 also show the contribution of total releases from Webb Tract and Bacon Island.

Storage Levels: Figure 5.5 shows the monthly average reservoir storage levels for Webb Tract and Bacon Island for a wet year (1986), below normal year (1979), and dry year (1987). Results for the wet and below normal years indicate that the reservoirs are filled during February, stay full through June, and are emptied during July. Results for the dry year indicate that the reservoirs remain empty throughout the year. There are dry years in which the reservoirs are operated, contradicting this trend.

Reservoir Operations: Reservoir operations for a wet year (1986), below normal year (1979), and two dry years (1987 and 1985) are shown for Webb Tract in Figures 5.6, 5.7, 5.8 and 5.9 and for Bacon Island in Figures 5.10, 5.11, 5.12 and 5.13. These figures show reservoir island diversions, releases and storage level on a daily basis. The values shown are average daily values and do not reflect fluctuations within the same day. Results indicate that In-Delta Storage reservoir operations are similar during below normal and wet years. Figures 5.8 and 5.12 show that the project is not operated during a dry year such as 1987; however, there are dry years in which the project is operated. For example, Figures 5.9 and 5.13 show the project being operated during a dry year (1985) that is preceded by and followed by wet years.

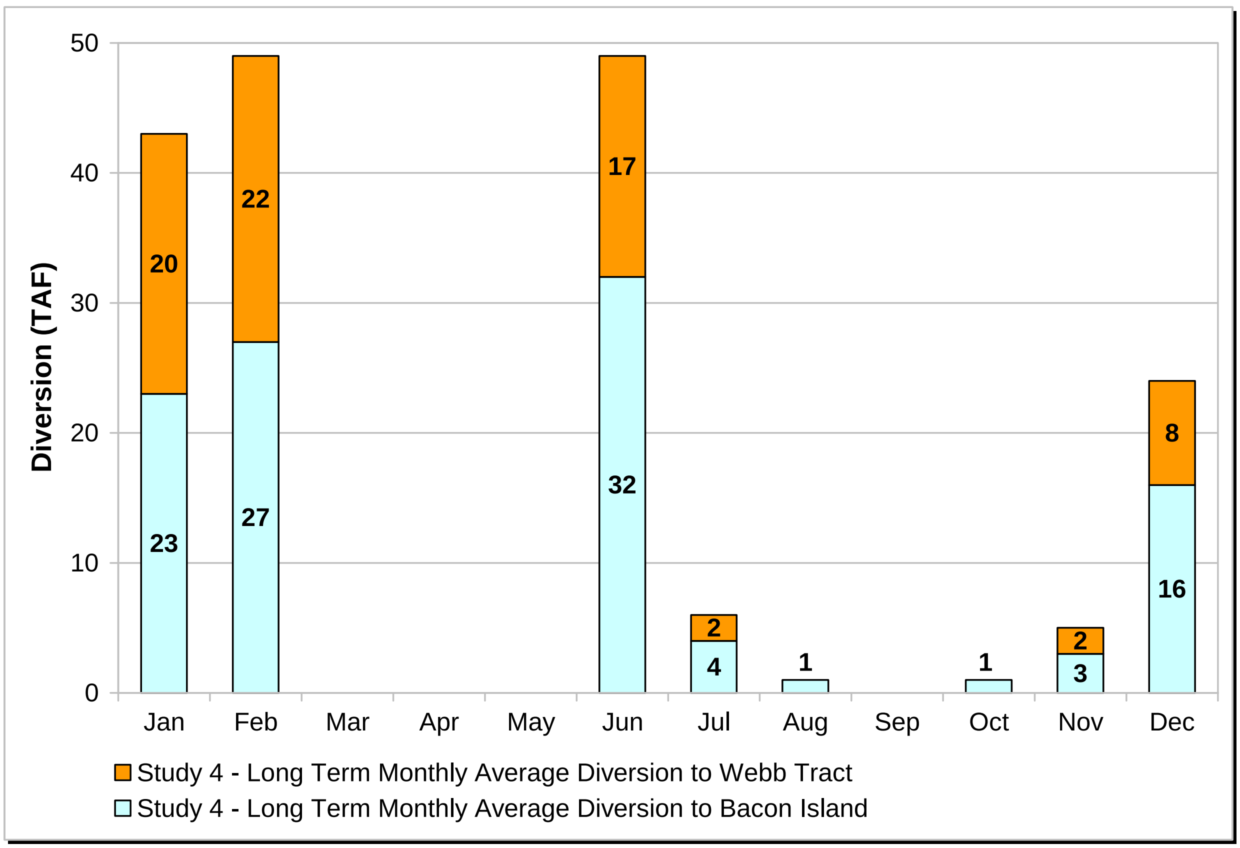


Figure 5.1: Long-Term Monthly Average Diversions to In-Delta Storage – Study 4

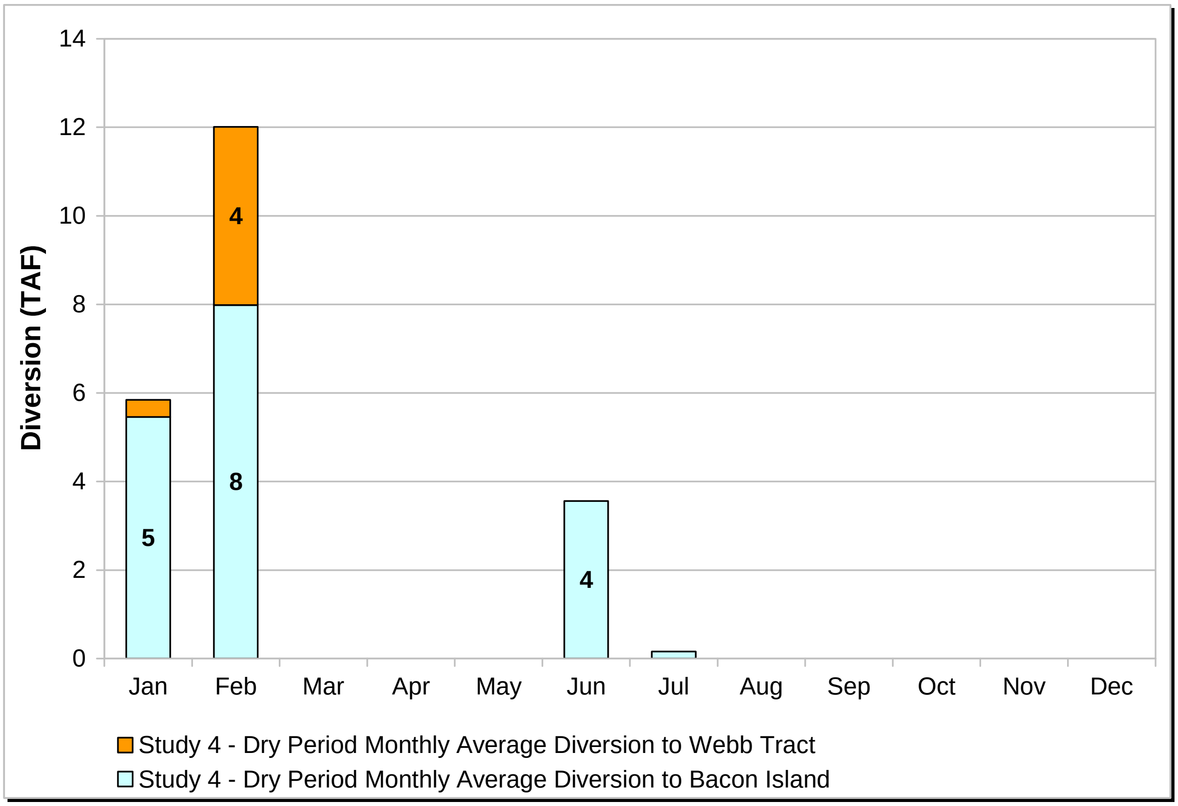


Figure 5.2: Dry Period Monthly Average Diversions to In-Delta Storage – Study 4

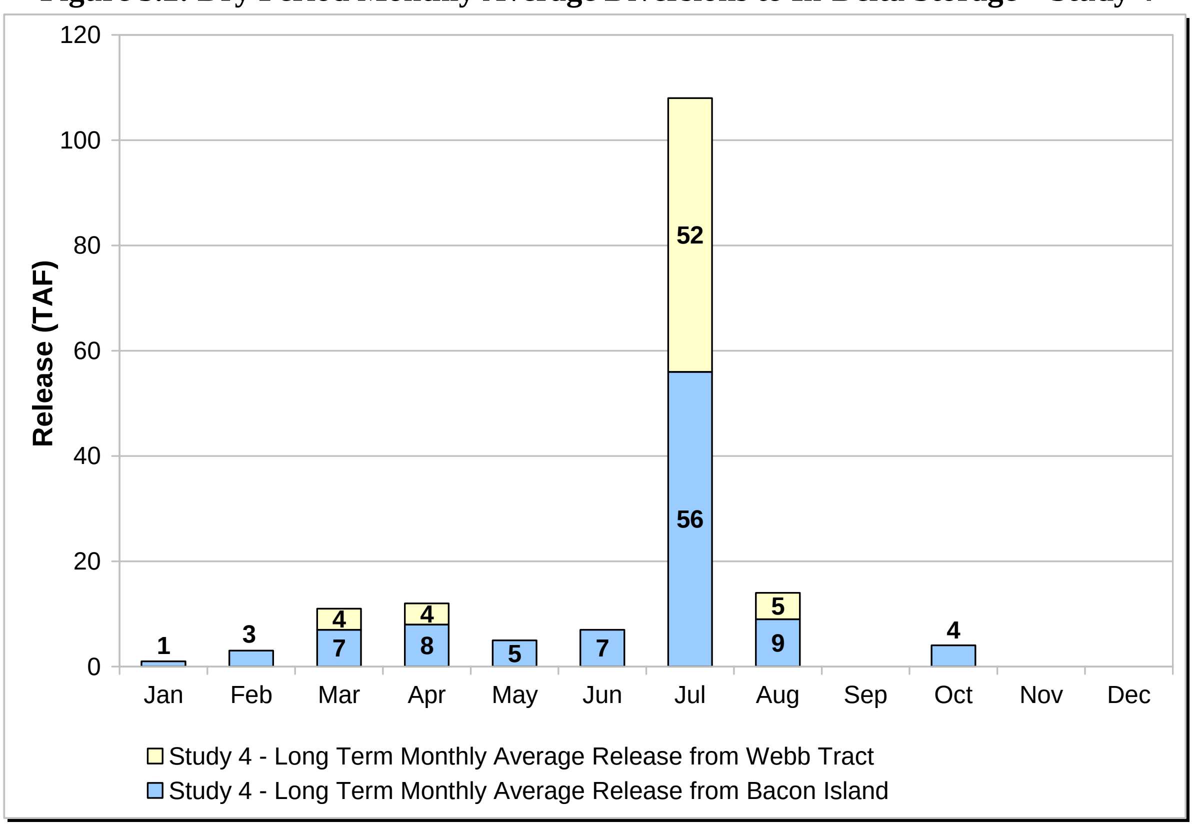


Figure 5.3: Long-Term Monthly Average Releases from In-Delta Storage – Study 4

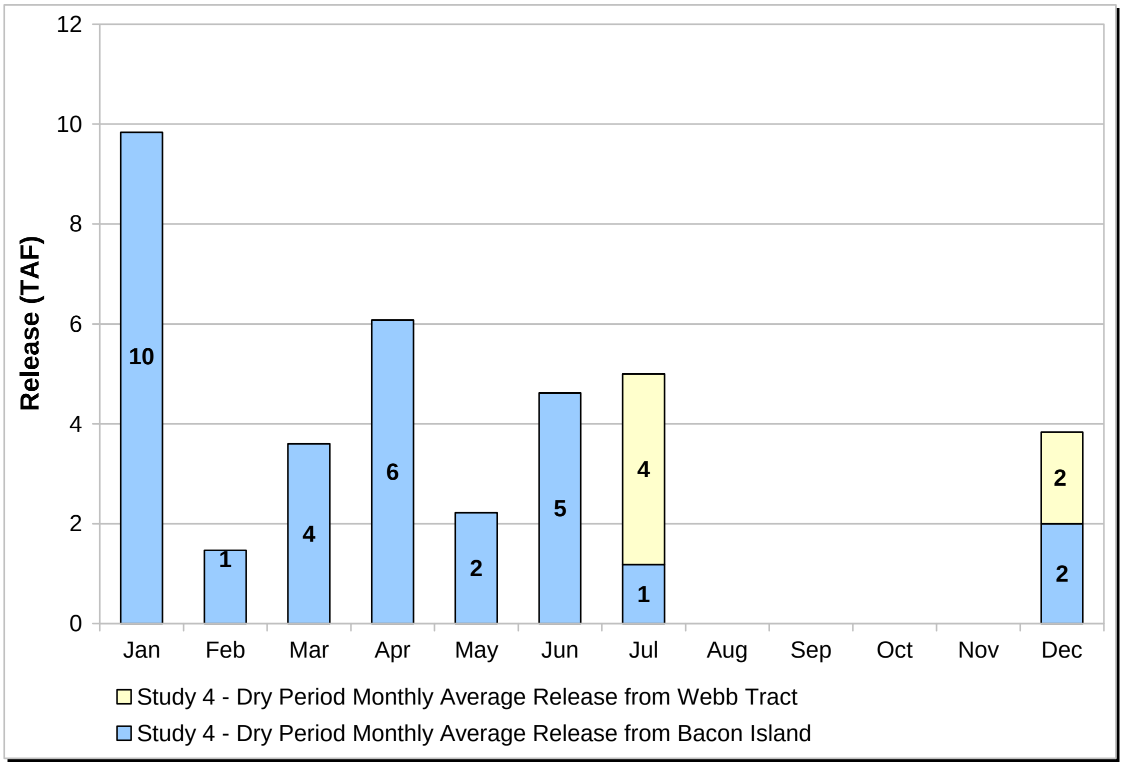


Figure 5.4: Dry Period Monthly Average Releases from In-Delta Storage – Study 4

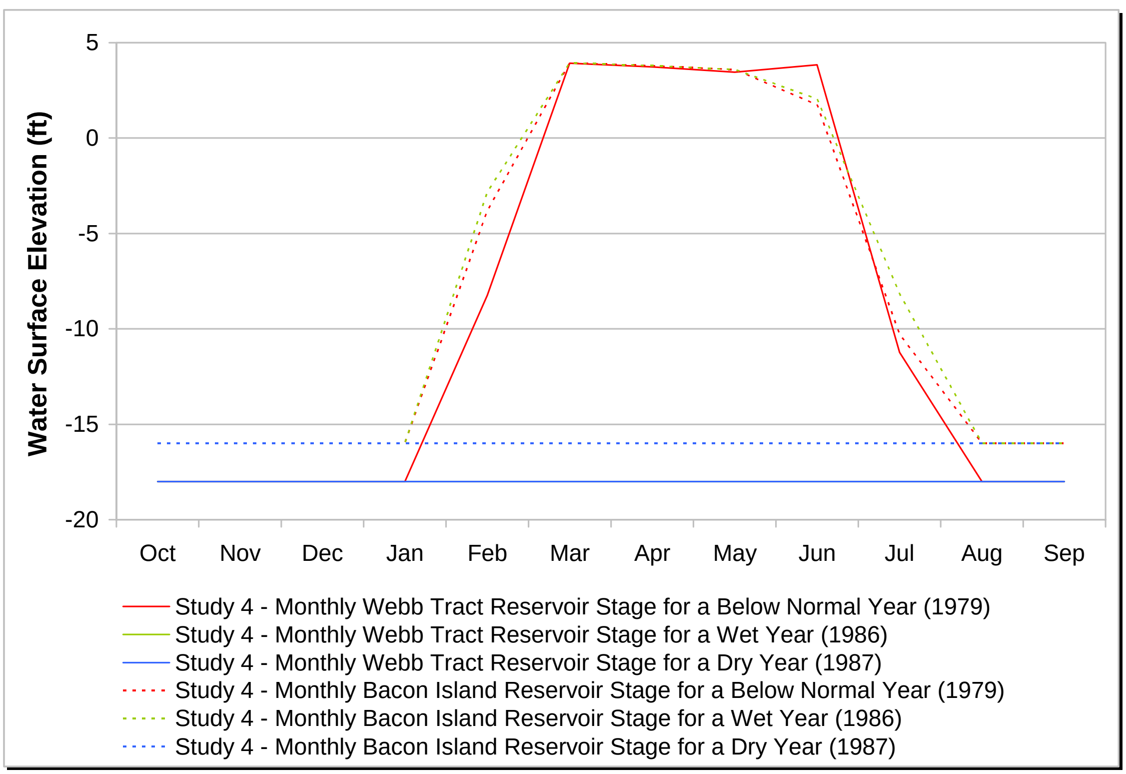


Figure 5.5: Monthly Average Reservoir Storage Level – Study 4

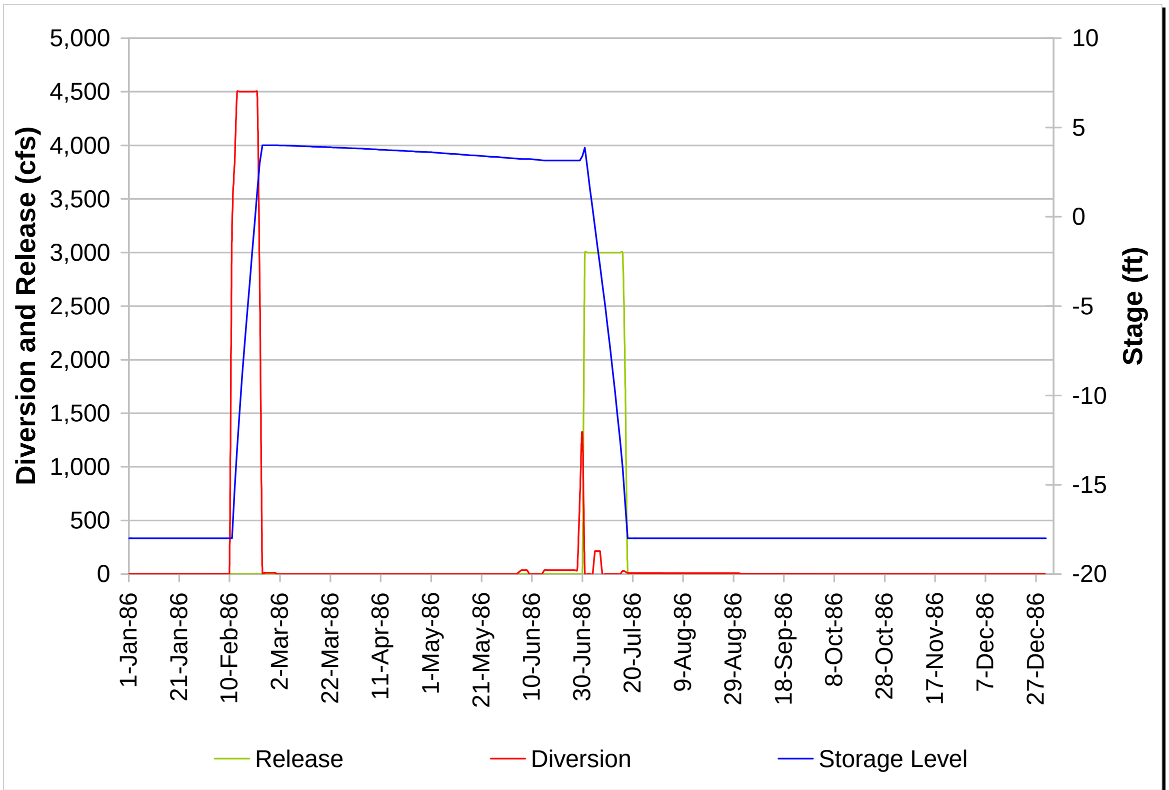


Figure 5.6: Webb Tract Operations in Wet Year (1986) - Study 4

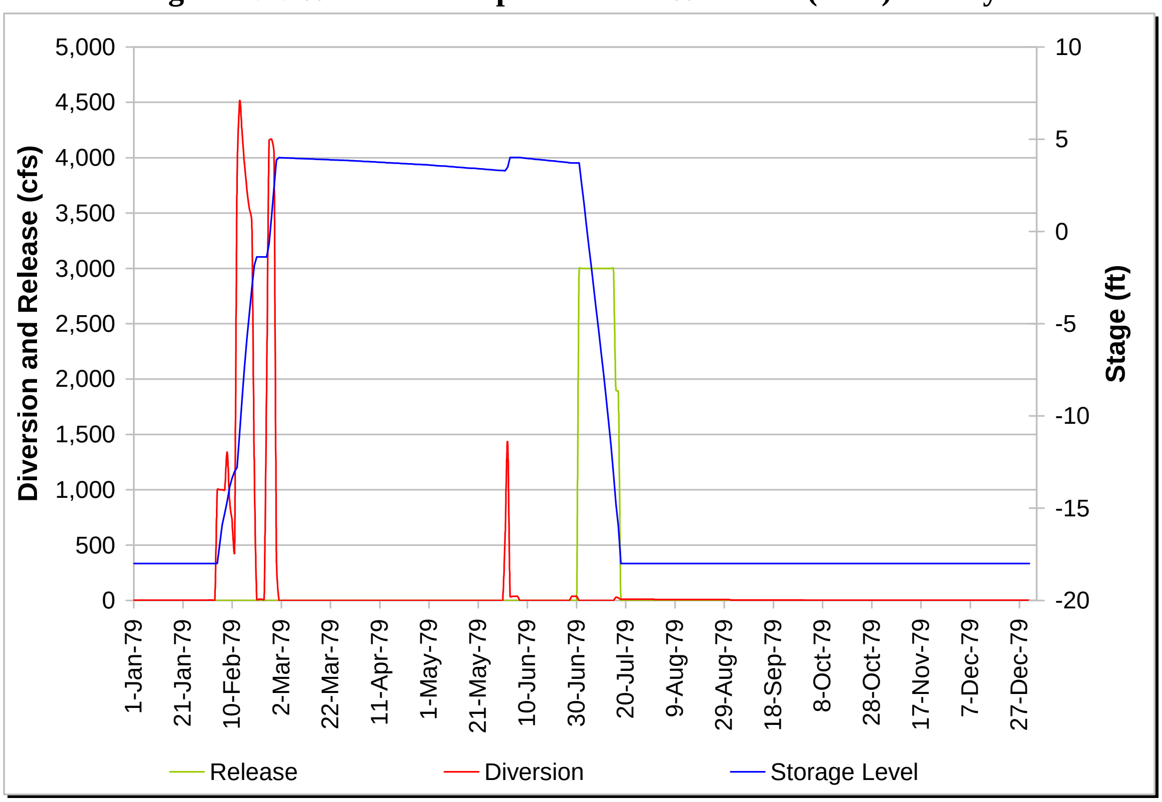


Figure 5.7: Webb Tract Operations in Below Normal Year (1979) - Study 4

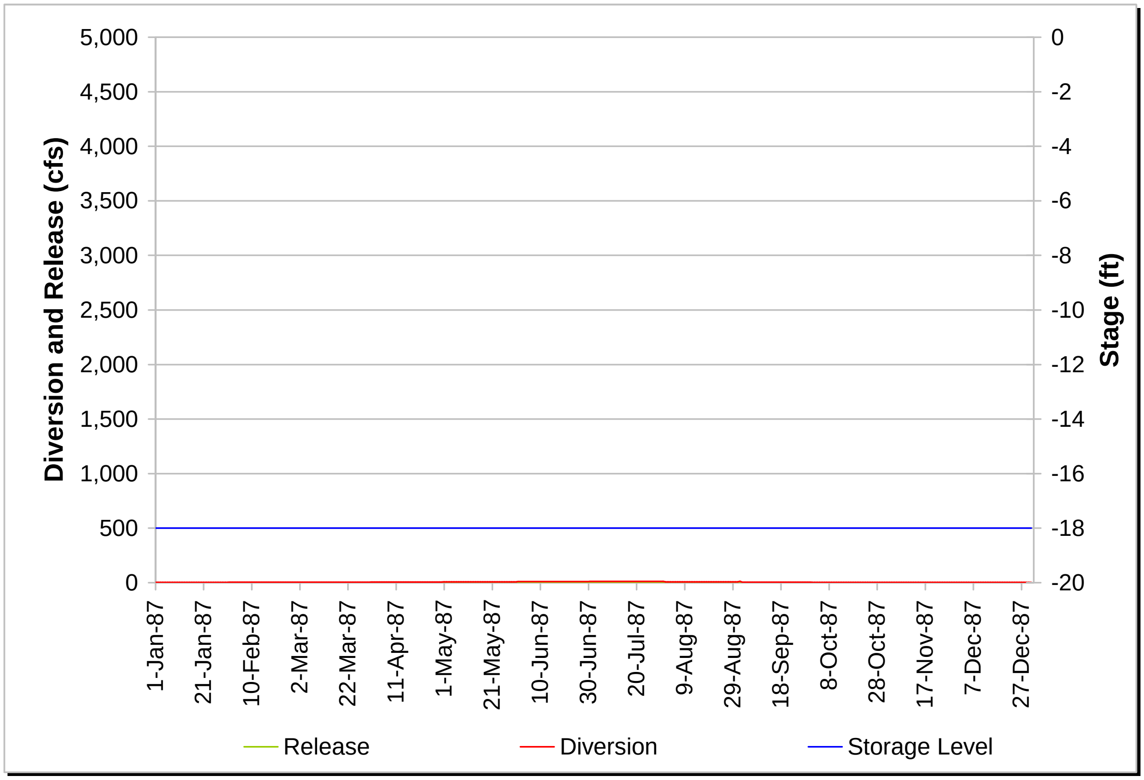


Figure 5.8: Webb Tract Operations in Dry Year (1987) - Study 4

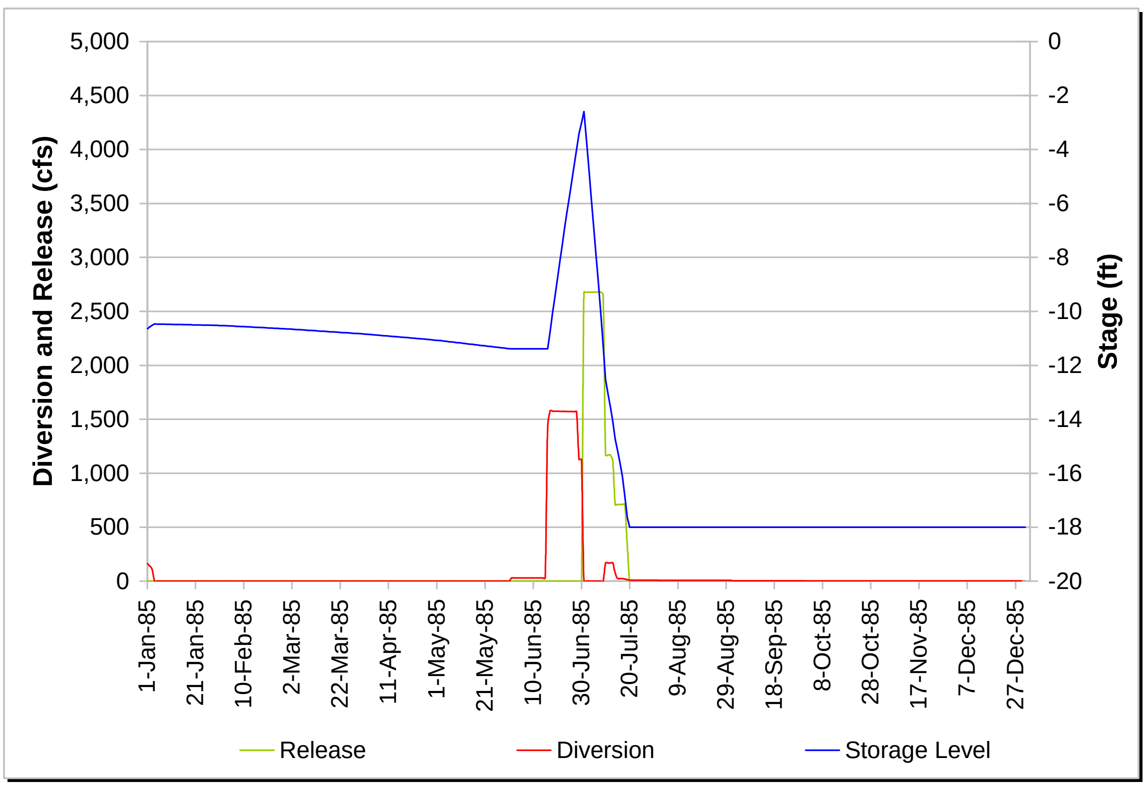


Figure 5.9: Webb Tract Operations in Dry Year (1985) - Study 4

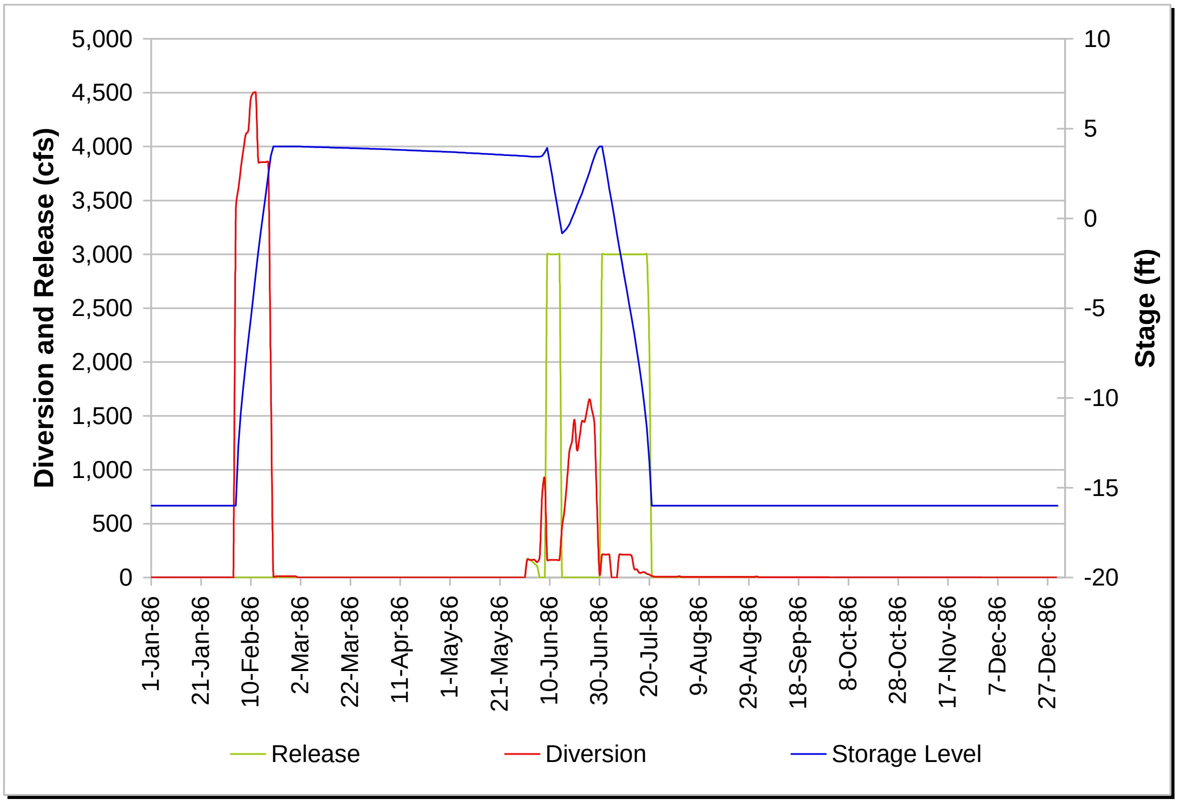


Figure 5.10: Bacon Island Operations in Wet Year (1986) - Study 4

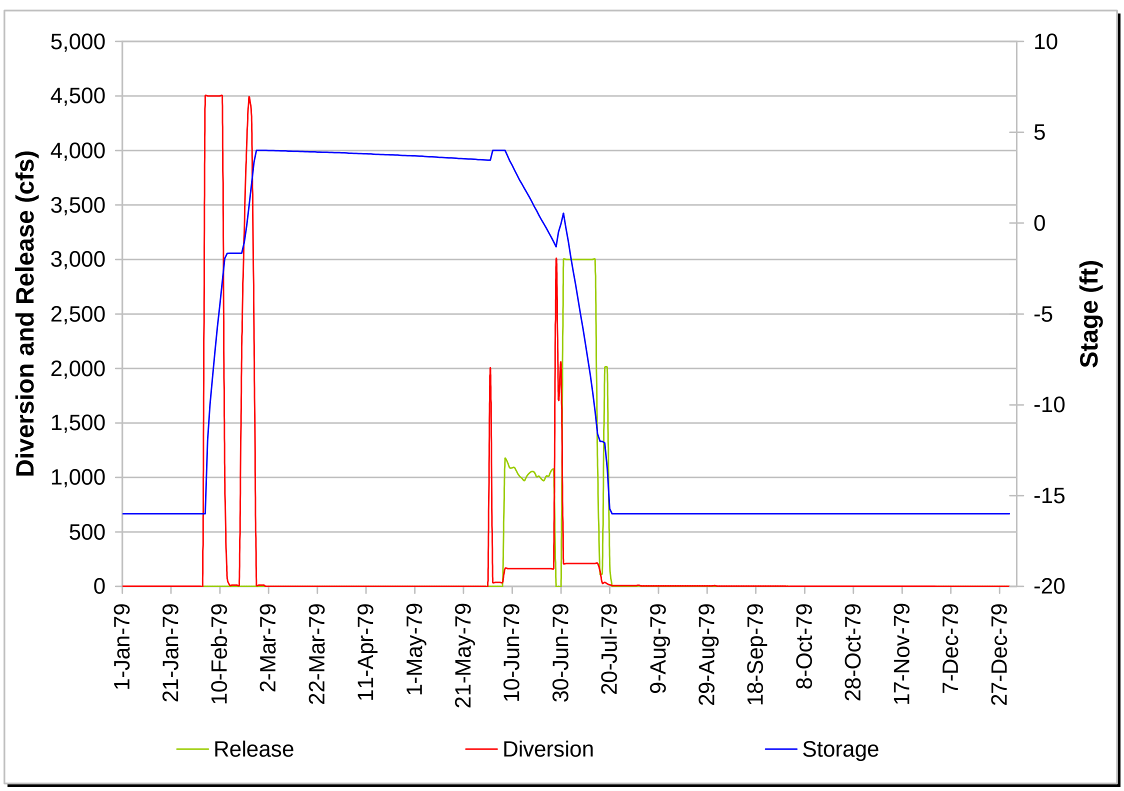


Figure 5.11: Bacon Island Operations in Below Normal Year (1979) - Study 4

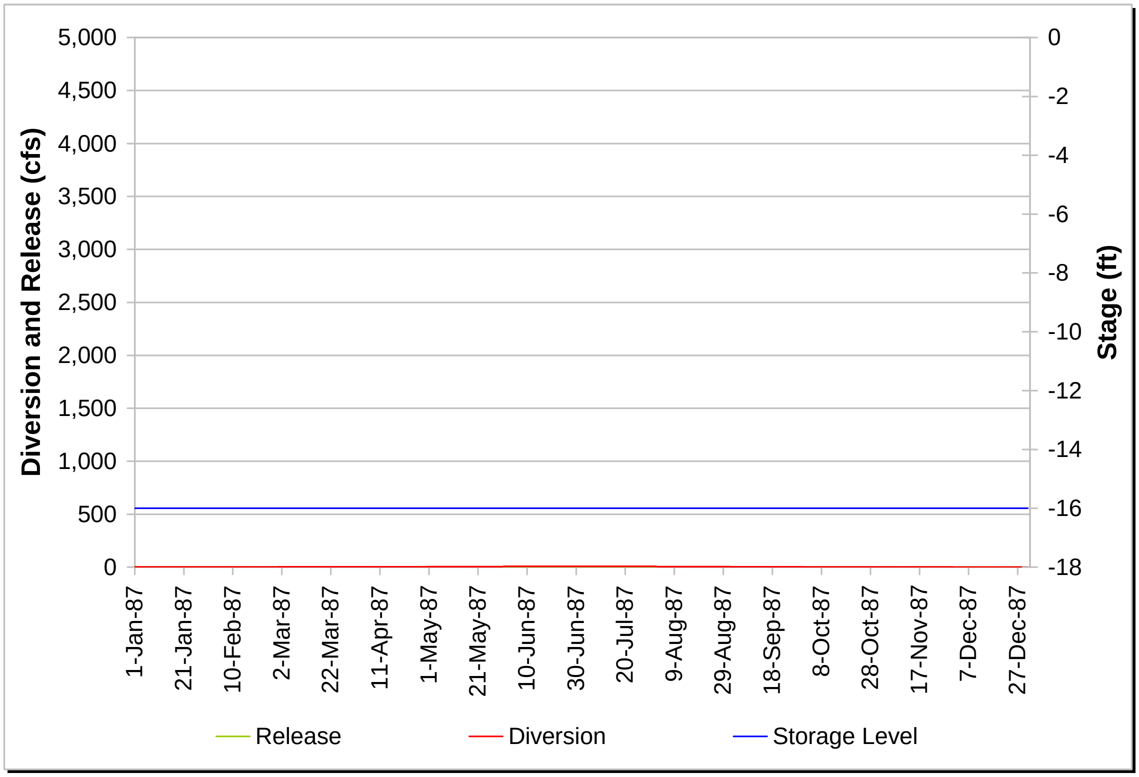


Figure 5.12: Bacon Island Operations in Dry Year (1987) - Study 4

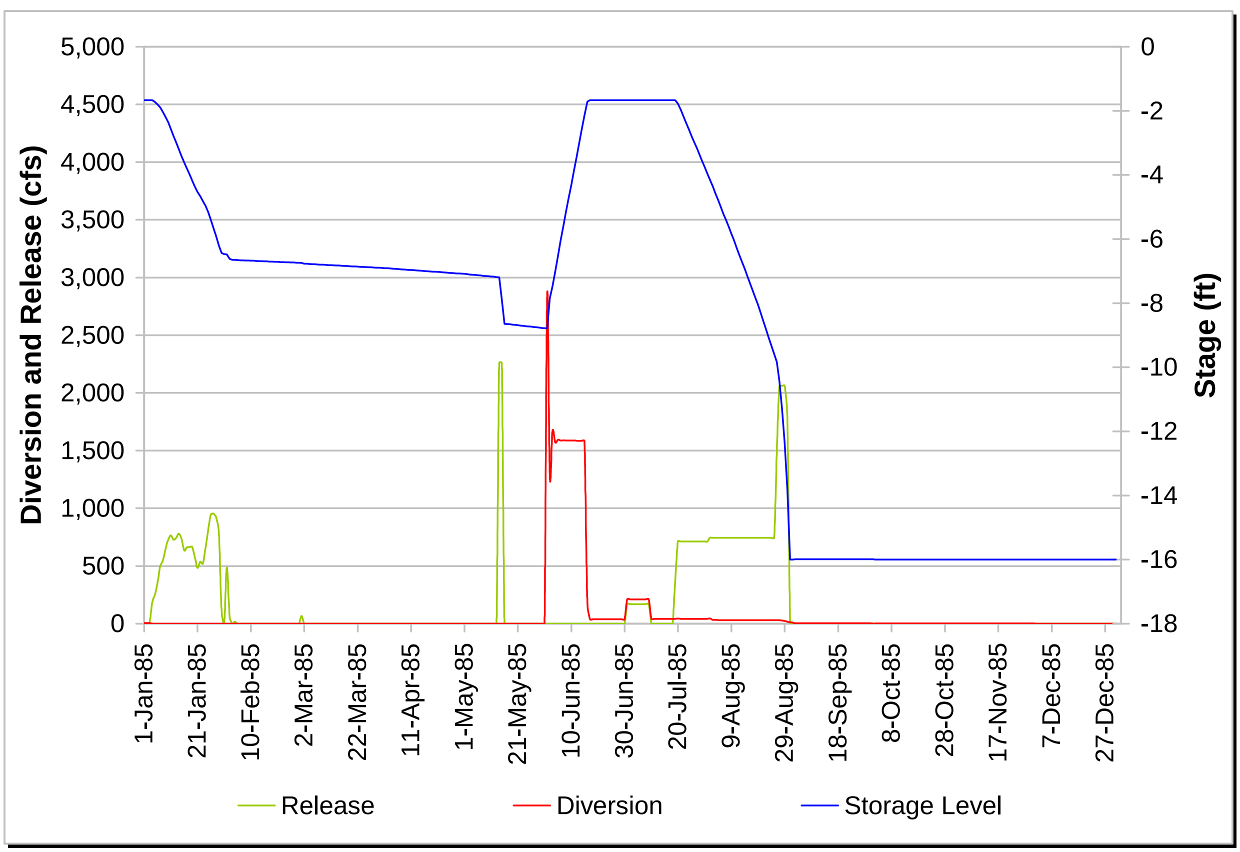


Figure 5.13: Bacon Island Operations in Dry Year (1985) - Study 4

5.3 Assessment of Project Benefits for Sample Operational Scenarios

The In-Delta Storage Project can provide benefits such as water supply reliability, system operational flexibility, additional carryover storage, Environmental Water Account assets, Ecosystem Restoration Program flows, in-lieu recharge for transfer of water for other statewide urban and agriculture users, County groundwater, and Delta water quality improvements. This section discusses these potential benefits of In-Delta Storage and presents some operational study results for the three sample operational scenarios.

5.3.1 Water Supply Reliability

The In-Delta Storage Project can improve water supply reliability for the state and federal water supply systems. The project can produce additional water deliveries to urban and agricultural water users, create additional upstream carryover storage and release water quickly for environmental needs.

Results shown in Table 5.1 indicate that all three sample operational scenarios provide increases in both SWP and CVP deliveries and Lake Oroville carryover storage over the No-Action Base study. Figure 5.14 compares average annual SWP and CVP deliveries of the No-Action Base study to Study 4. During most years, In-Delta Storage provides an increase in SWP and CVP deliveries over the No-Action Base.

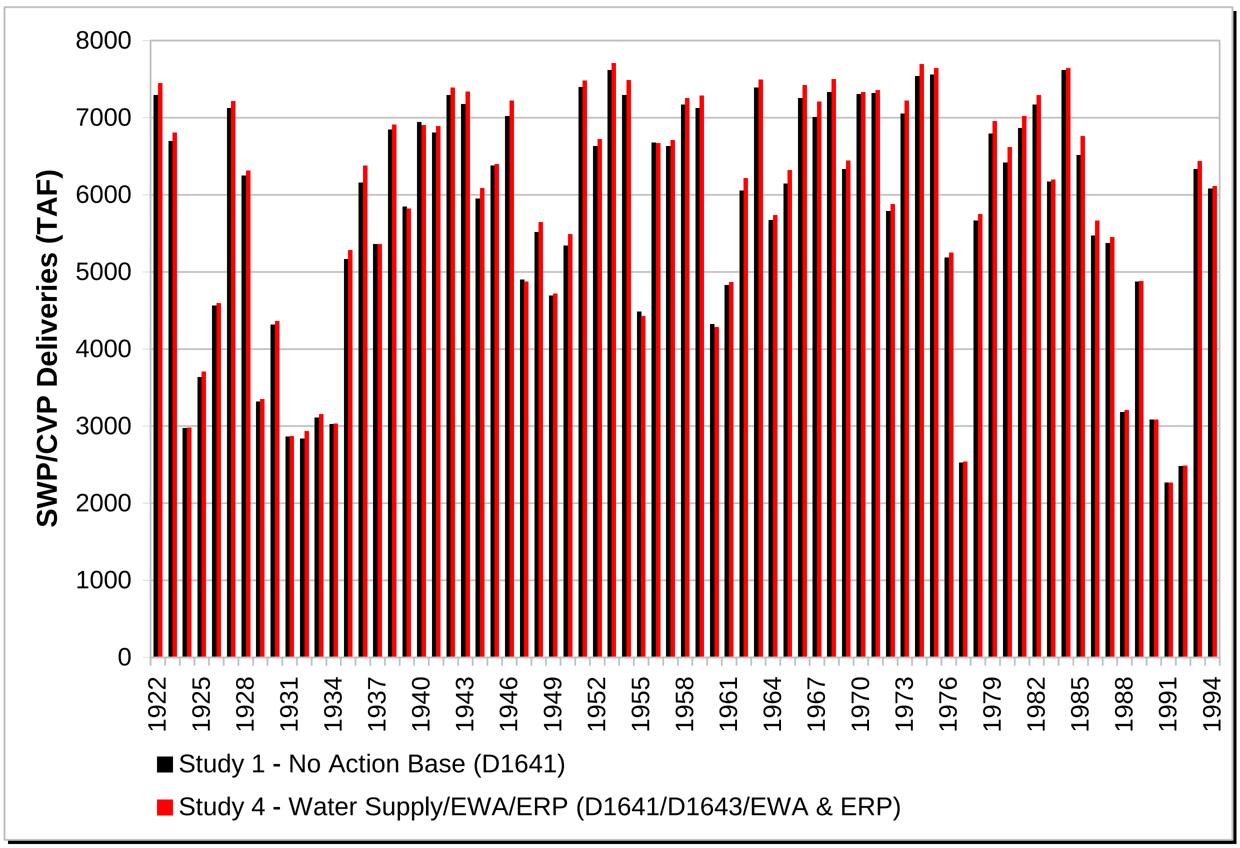


Figure 5.14: Average Annual SWP/CVP Deliveries - Study 4

Figure 5.15 shows the annual exceedance frequency of SWP/CVP deliveries under the No-Action Base and the three sample operational scenarios. This exceedance curve represents the likelihood that deliveries of a specific amount will be met or exceeded. For example, total SWP and CVP deliveries under Study 4b are at least 5,300 TAF/year in 70% of the years.

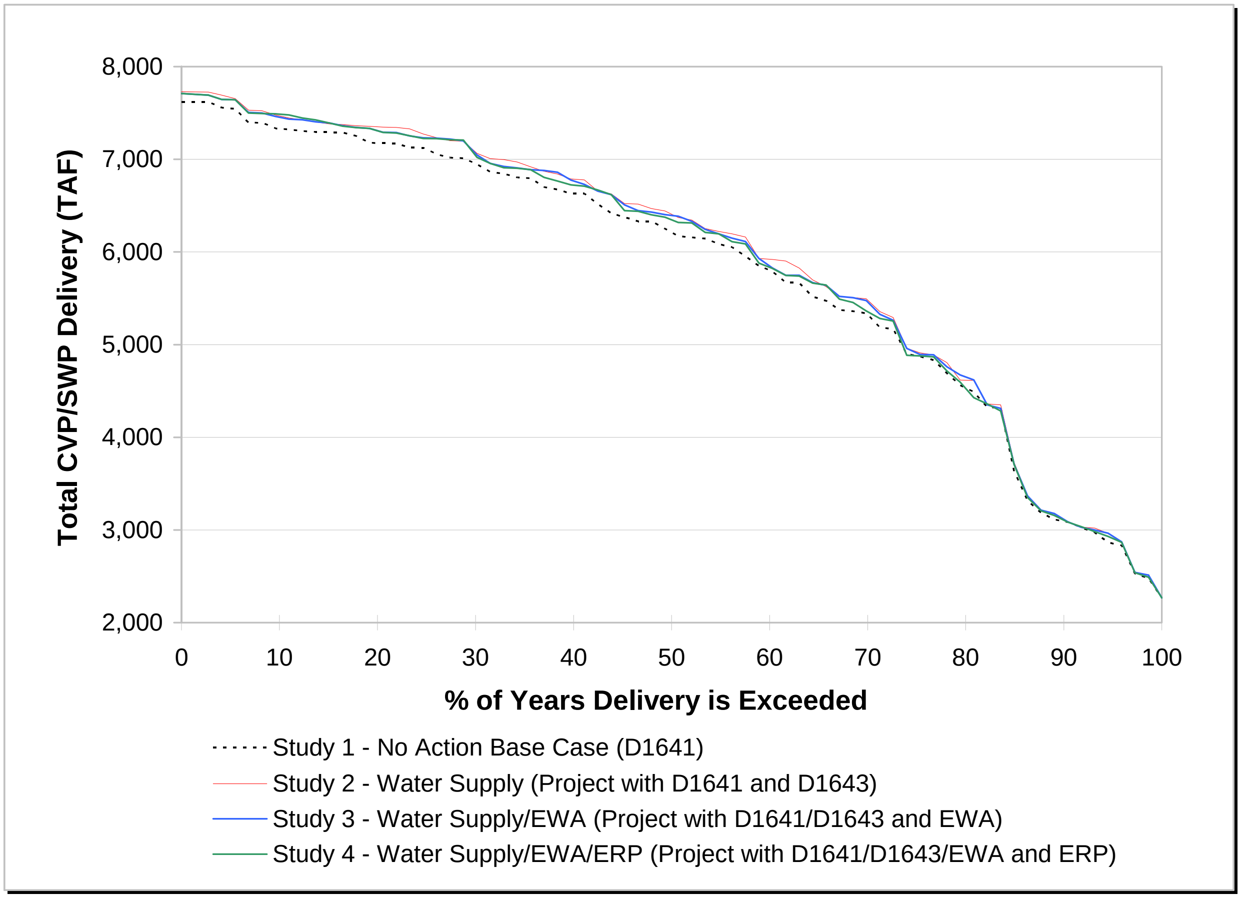


Figure 5.15: Water Supply Reliability

5.3.2 SWP and CVP System Operational Flexibility

The In-Delta Storage Project would improve the operational flexibility of the CVP and SWP. The project's strategic location within the Delta provides enhanced flexibility in responding to short-term operational needs resulting in greater environmental protection and water supply reliability.

Due to its strategic location in the Delta, In-Delta Storage can respond quickly to accommodate real time operational needs. The In-Delta Storage Project provides a significant amount of water that could be used on short notice for export through the south Delta pumps, or release for real time Delta outflow, water quality and fisheries flows. This gives the water system unique operational flexibility that cannot be supplied by upstream storage that requires greater travel times for released water to reach the Delta.

5.3.3 Carryover Storage

The system-wide benefits of In-Delta Storage extend not only to south of the Delta but are also realized upstream. A portion of SWP and CVP obligations are met by In-Delta Storage and as a result of In-Delta Storage operations, upstream carryover storage becomes available for other potential system-wide uses such as benefiting the cold water pool, recreation and improving the reliability of other project deliveries. A large part of this additional carryover storage occurs in Lake Oroville, as shown in Figure 5.16. It should be noted, however, that the potential uses of this additional carryover storage were not modeled. If the potential uses are modeled, negative impacts to other water users should be avoided.

Uses of this storage can be optimized through further operational studies in coordination with upstream reservoirs. Operations can be refined by:

- flow augmentation in the Sacramento River,
- moving water during fall months to In-Delta Storage for Delta ecosystem ,EWA and ERP use, and
- using water for temperature control and other water quality benefits.

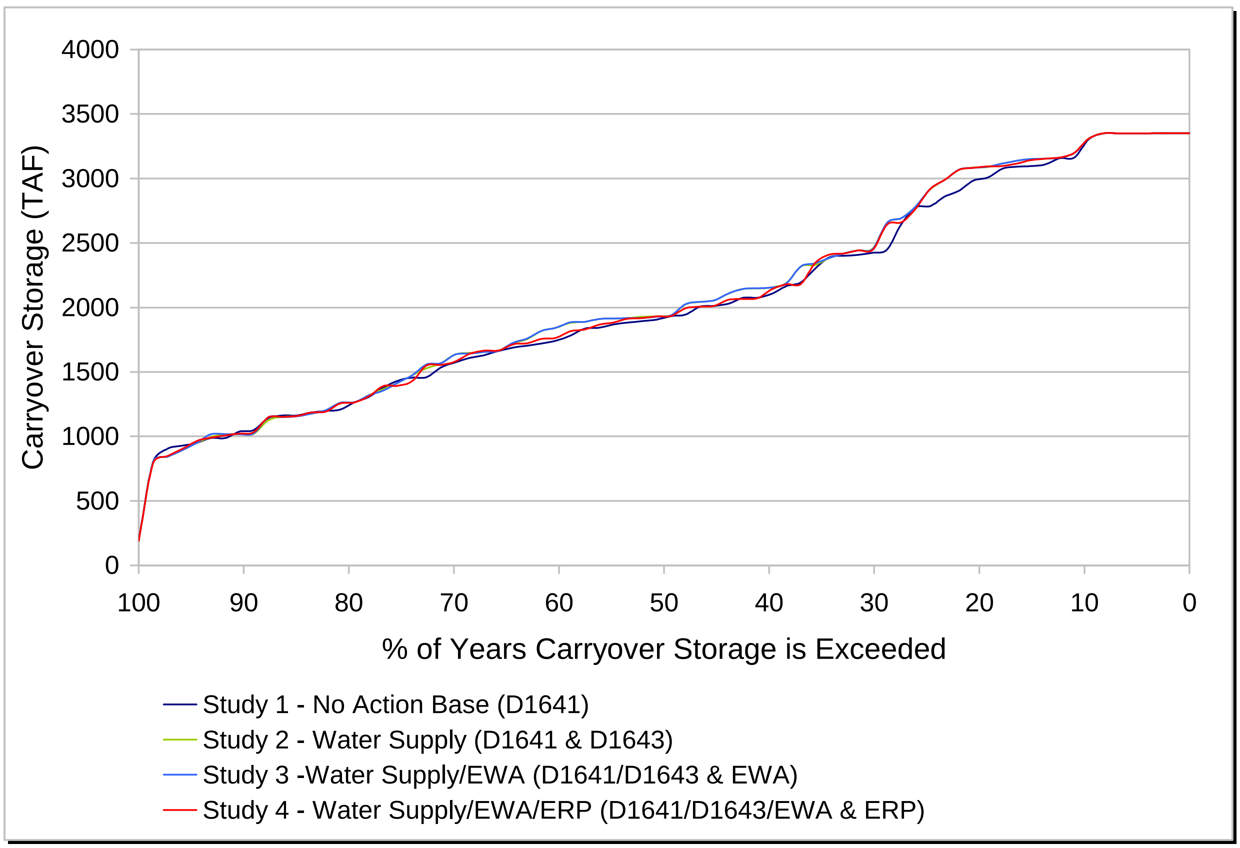


Figure 5.16: Long-Term Oroville Carryover Storage

5.3.4 Environmental Water Account

In-Delta Storage could provide water needed to support the EWA program, enhancing the EWA ability to respond to real-time fisheries needs and eliminating the need to purchase a substantial portion of water, from other sources, needed by EWA each year.

It was assumed that any water that was not needed by SWP and CVP as of May 1 could be purchased for EWA. EWA is given a lower priority to the water than the refuges and groundwater conjunctive use, but from July through September Banks permitted capacity is increased from 8000 cfs to 8500 cfs with the extra 500 cfs dedicated to moving In-Delta water for the EWA. This guarantees that, while low in priority, the EWA can purchase a significant share of the unwanted In-Delta Storage water because it can move water that the refuges and groundwater recharge are otherwise unable to.

Figure 5.17 shows the annual exceedance frequency of reservoir island releases for EWA compared to releases for SWP/CVP deliveries under Studies 3 and 4. This exceedance curve represents the likelihood that releases of a specific amount will be met or exceeded. For example, total releases for EWA under Study 4 are at least 40 TAF/year in 30% of the years. The island releases shown in this figure are additive. In other words, the total releases made are the summation of releases made for SWP/CVP deliveries and those made for EWA.

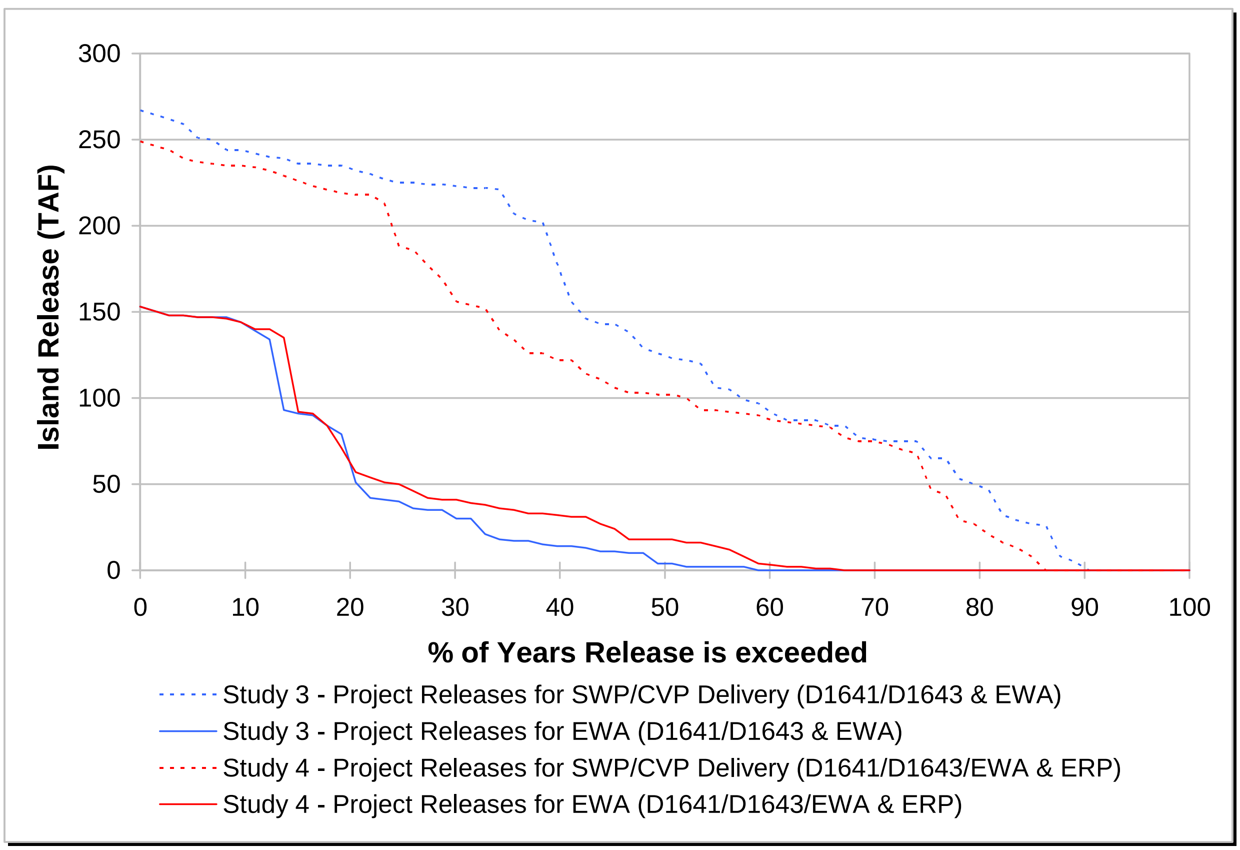


Figure 5.17: In-Delta Storage Supply Contribution to EWA

5.3.5 Ecosystem Restoration Program

The In-Delta Storage Project can provide water for ecosystem restoration actions to help restore and improve the health of the Bay-Delta system for all native species while reducing its water management constraints. This project can help maintain flow regimes in the Delta that support the recovery and restoration of native aquatic and riparian species and biotic communities. Figure 5.18 shows the annual exceedance frequency of reservoir island releases for ERP Delta flows compared to releases for SWP/CVP deliveries under Study 4. The island releases shown in this figure are additive. In other words, the total releases made are the summation of releases made for SWP/CVP deliveries and those made for ERP.

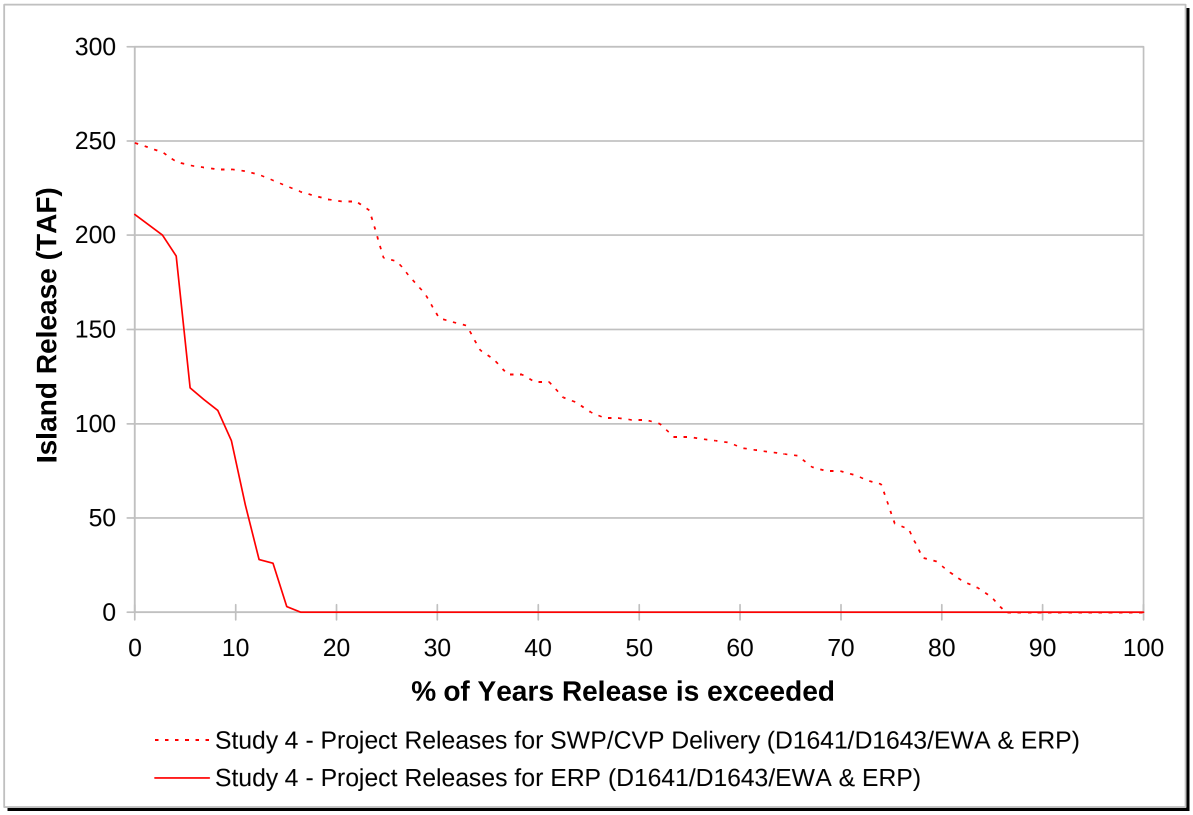


Figure 5.18: Dedicated In-Delta Storage Supply Contribution to ERP

5.3.6 Water Quality

The location of the 2 ppt salinity isohaline (X2 location) has been identified as an important indicator of estuarine habitat conditions within the Bay-Delta system. The location of X2 within Suisun Bay during the February to June period is thought to be directly and/or indirectly related to the reproductive success and survival of the early life stages for a number of estuarine species. Abundance of several estuarine species is greater when the X2 location during the spring occurs within the western portion of Suisun Bay with lower abundance correlated with those years when the X2 location is further to the east.

The In-Delta Storage Project has the potential to improve water quality in the Delta. Due to its strategic location, higher quality water released from the project may reduce salinity in the Delta when Delta water quality is poor. None of the operational studies conducted for this feasibility study emphasized improving water quality. With that said, studies emphasizing water quality improvements should be conducted to determine the extent to which In-Delta Storage can improve Delta water quality. Salinity changes are evaluated by DSM2 to determine if the CALSIM results are within the variations allowed by D1643. The CALSIM results indicate that the project's impact to X2 position and salinity are negligible. Further evaluations can be found in the Water Quality Investigations report.

5.4 Assessment of Impact Evaluation Scenarios

Many factors can affect the operation of the In-Delta Storage Project, but it is difficult to assess the combined impacts of multiple conditions at the same time. With that said, a number of impact evaluation scenarios were developed and analyzed to determine the potential impacts of various conditions on the project. This section discusses these potential impacts and presents some operational study results for the six impact evaluation scenarios. As mentioned earlier, the impact evaluation scenarios are based on Study 4.

The operational analyses presented in this section cover the impacts to the project of: applying D1643 water quality constraints; applying circulation to dilute potential DOC problems; applying fish and aquatic habitat protections during drought and extreme conditions; climate change; and changes in infrastructure such as operating in coordination with an expanded Los Vaqueros reservoir. Also, the impacts D1643 has on the projects ability to divert and deliver water were evaluated by running an In-Delta Storage operation unencumbered by this decision.

5.4.1 Water Supply Evaluations

Figure 5.19 shows changes in water supply, relative to the No-Action Base study, for Study 4 and all six impact evaluation studies. This figure also shows the relative affect that each impact evaluation scenario has on water supply relative to Study 4. In this figure, the total water supply quantity is separated into SWP/CVP deliveries, releases made for EWA and ERP flows. Each of the impact evaluation scenarios are discussed further in the following sections.

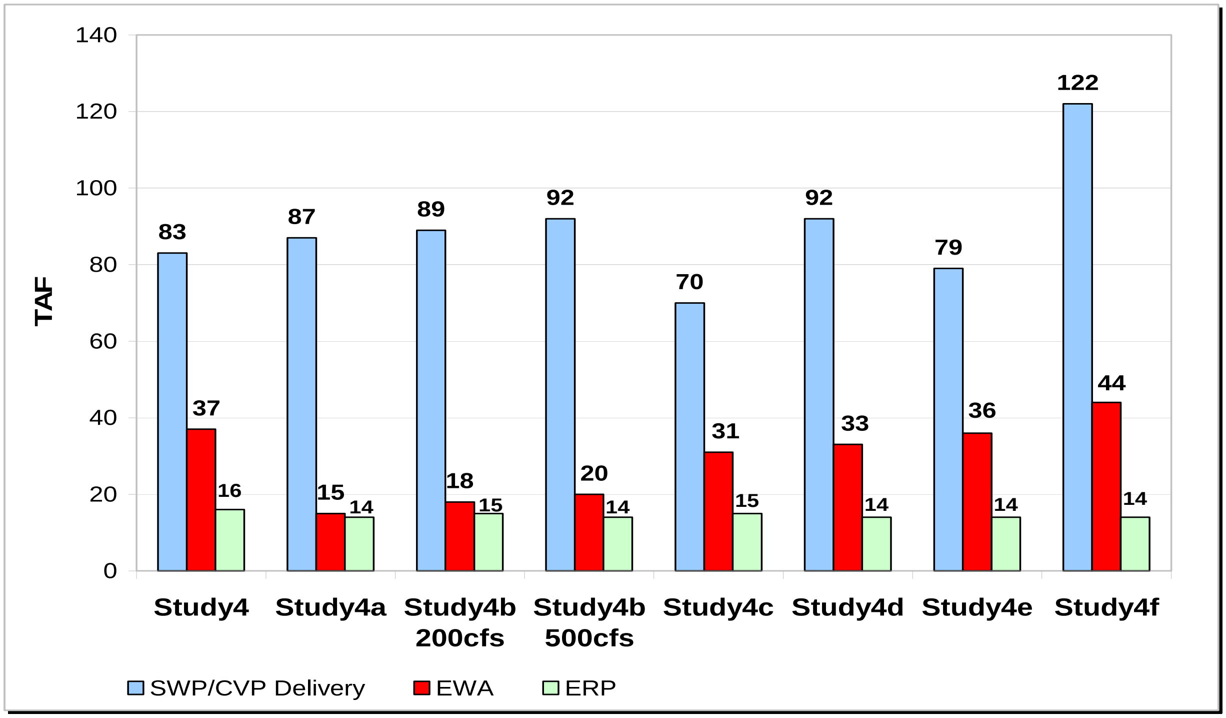


Figure 5.19: Long-Term Average Annual Change in Water Supply

5.4.2 Organic Carbon Evaluations

Study 4a was run to obtain the initial project conditions with organic constraints applied. The total impact to water supply when organic carbon constraints are applied is only about 20 taf/year on average. Circulating water onto and off the reservoir islands can improve water quality (by reducing organic carbon) in the reservoirs, thereby reducing the total impact to water supply. Study 4b included two circulation runs, one at 200 cfs and another at 500 cfs. Sensitivity analyses showed that circulating more than 500 cfs does not further reduce organic carbon concentrations on the reservoir islands.

Results for the 500 cfs circulation run (Study 4b 500) are presented here. Similar to the types of results presented in Section 5.2 for Study 4, the results presented below include long-term and dry period monthly average diversion and release amounts, as well as reservoir operations for a wet year (1986), below normal year (1979), and two dry years (1987 and 1985). In addition, organic carbon operations are presented for three locations: Banks Pumping Plant, Tracy Pumping Plant and Contra Costa Intake for 1986, 1979, 1987 and 1985.

Diversions: Figures 5.20 through 5.23 show diversions to In-Delta Storage under a circulation operation for the long-term and dry period. The diversions shown are split into diversions for storage (Figures 5.20 and 5.22) and diversions strictly for circulation (Figures 5.21 and 5.23). These figures show that diversions occur during every month of the year for all years, whereas without circulation (Study 4), very little if any diversions are made during the spring and summer months (with the exception of June) over the long-term. These figures also show the contribution of total diversions going to Webb Tract and Bacon Island and present average monthly values, so the extremes are not apparent.

Releases: Although not shown, the patterns of releases made strictly for circulation are identical to the patterns shown for diversions in Figures 5.21 and 5.23. This is expected since under circulation operations diversions equal releases, resulting in no net change to the Delta water balance. Figures 5.24 and 5.25 show releases made from storage (without circulation releases). Similar to operating without circulation, these figures show that releases from In-Delta Storage typically occur during the spring and early summer months with the majority of releases occurring in July. The magnitude of releases that occur February through June are similar for the long-term and dry periods; however, releases during July are reduced significantly during the dry period.

Reservoir Operations: Reservoir operations with circulation for a wet year (1986), below normal year (1979), and two dry years (1987 and 1985) are shown for Webb Tract in Figures 5.26, 5.27, 5.28 and 5.29 and for Bacon Island in Figures 5.30, 5.31, 5.32 and 5.33. These figures show reservoir island diversions, releases and storage level on a daily basis. The values shown are average daily values and do not reflect fluctuations within the same day. Results indicate that In-Delta Storage reservoir operations are similar during below normal and wet years. Figures 5.28 and 5.32 show that the project is not operated during a dry year such as 1987; however, there are dry years in which the project is operated. For example, Figures 5.29 and 5.33 show the project being operated during a dry year (1985) that is preceded by and followed by wet years. The results from 1985 indicate that under circulation operations the project operations are similar in pattern and magnitude to the below normal and wet years, without the increased diversions during February.

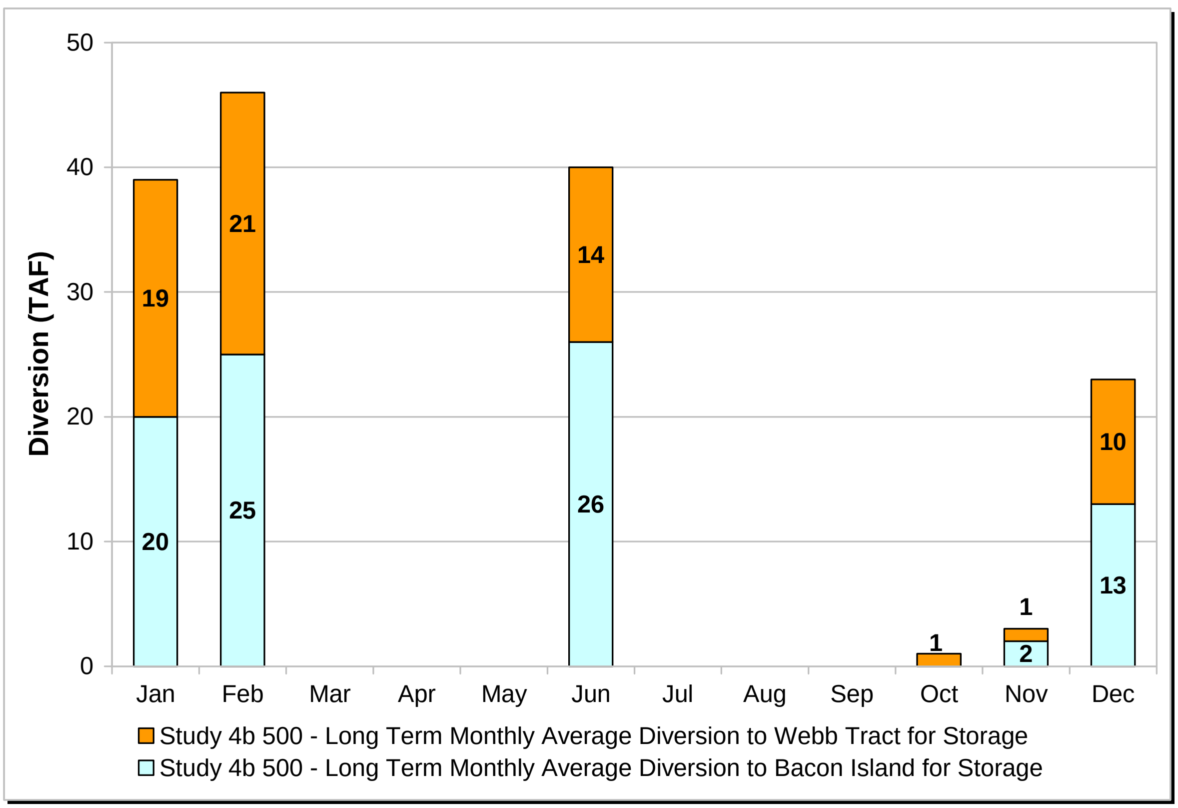


Figure 5.20: Long-Term Monthly Average Diversions for Storage – Study 4b

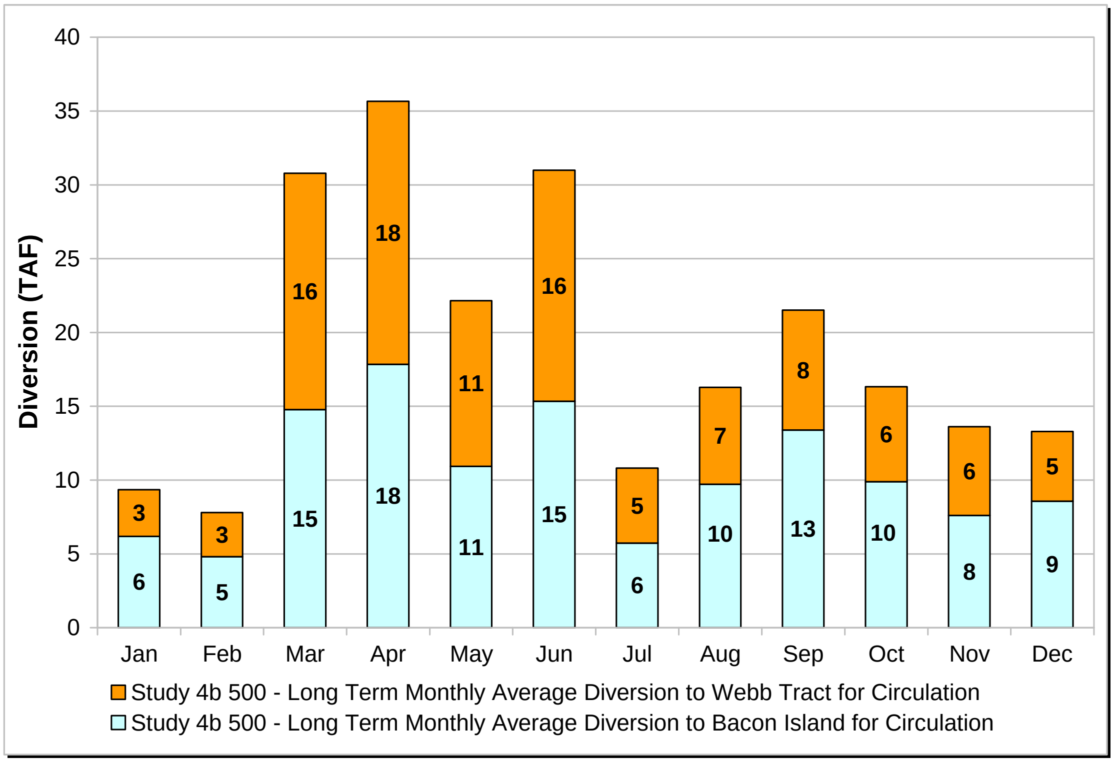


Figure 5.21: Long-Term Monthly Average Diversions for Circulation – Study 4b

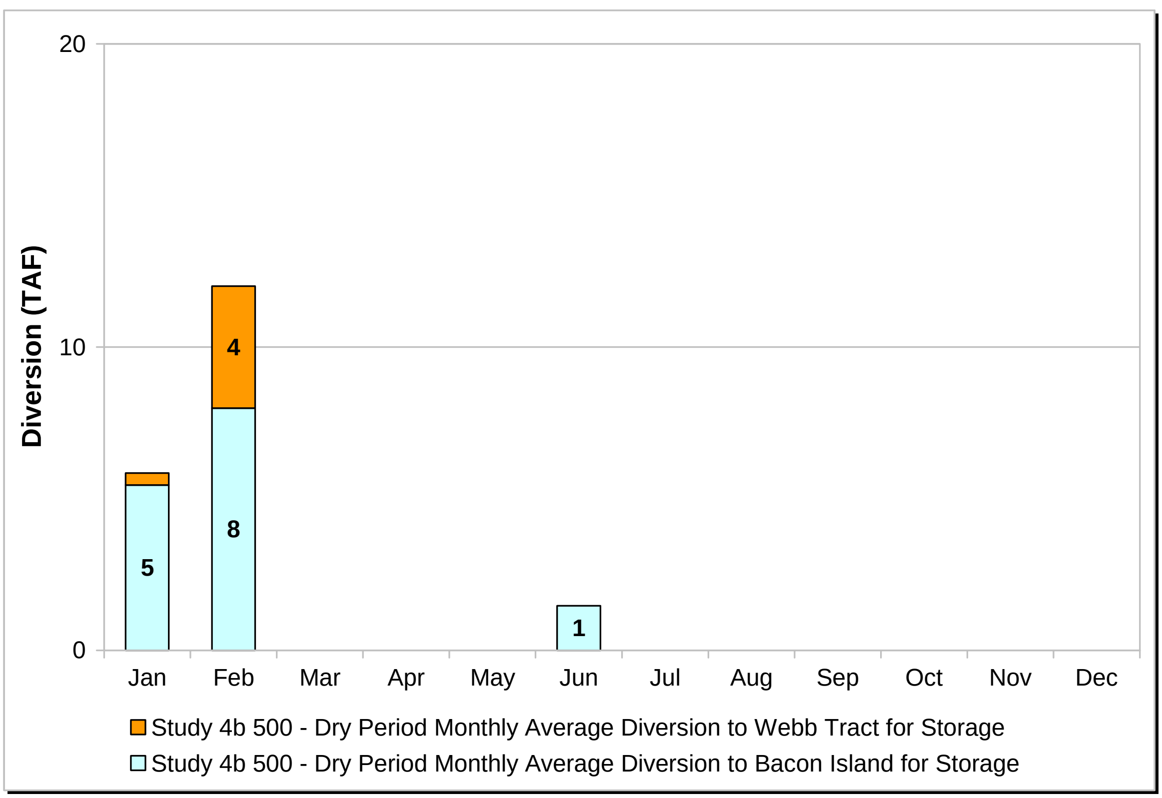


Figure 5.22: Dry Period Monthly Average Diversions for Storage – Study 4b

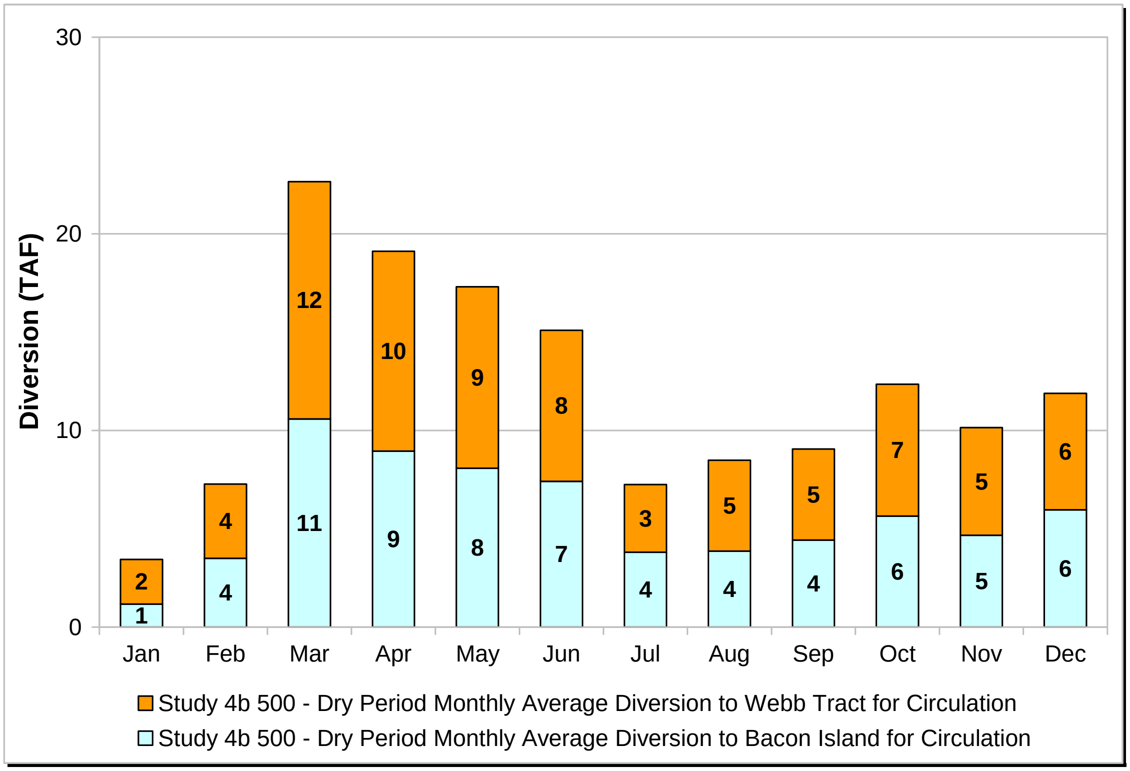


Figure 5.23: Dry Period Monthly Average Diversions for Circulation – Study 4b

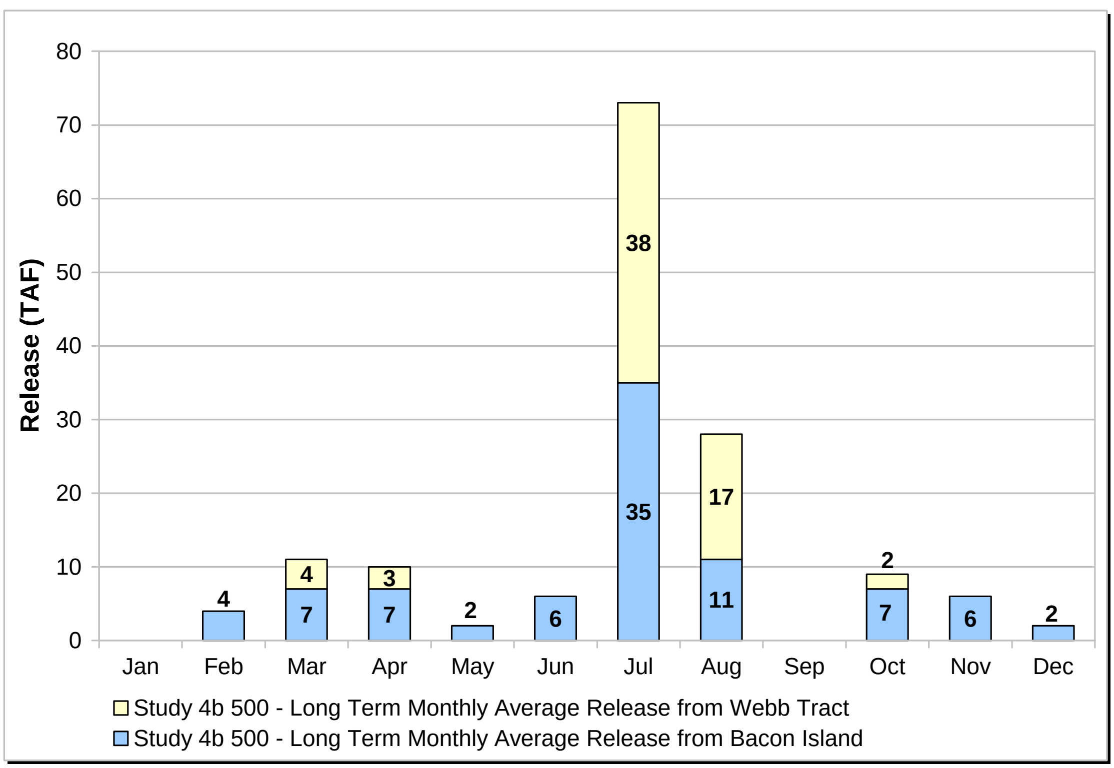


Figure 5.24: Long-Term Monthly Average Operational Releases from IDS – Study 4b

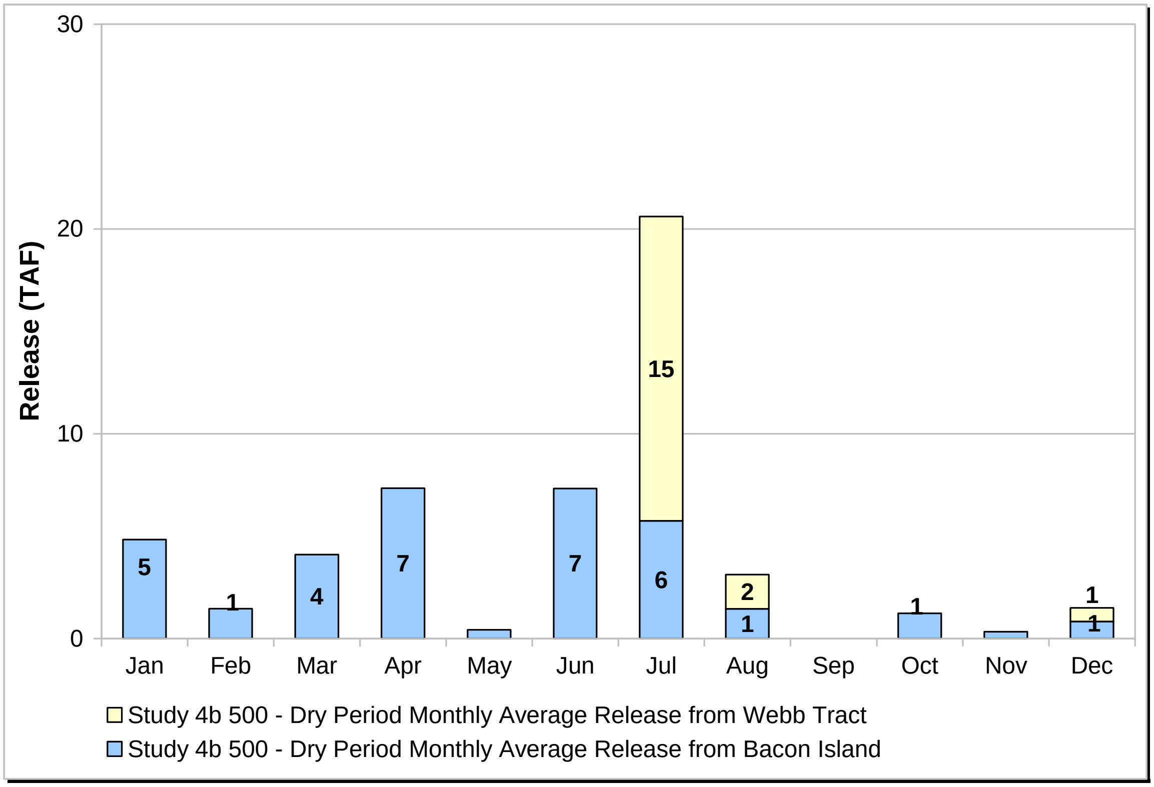


Figure 5.25: Dry Period Monthly Average Operational Releases from IDS – Study 4b

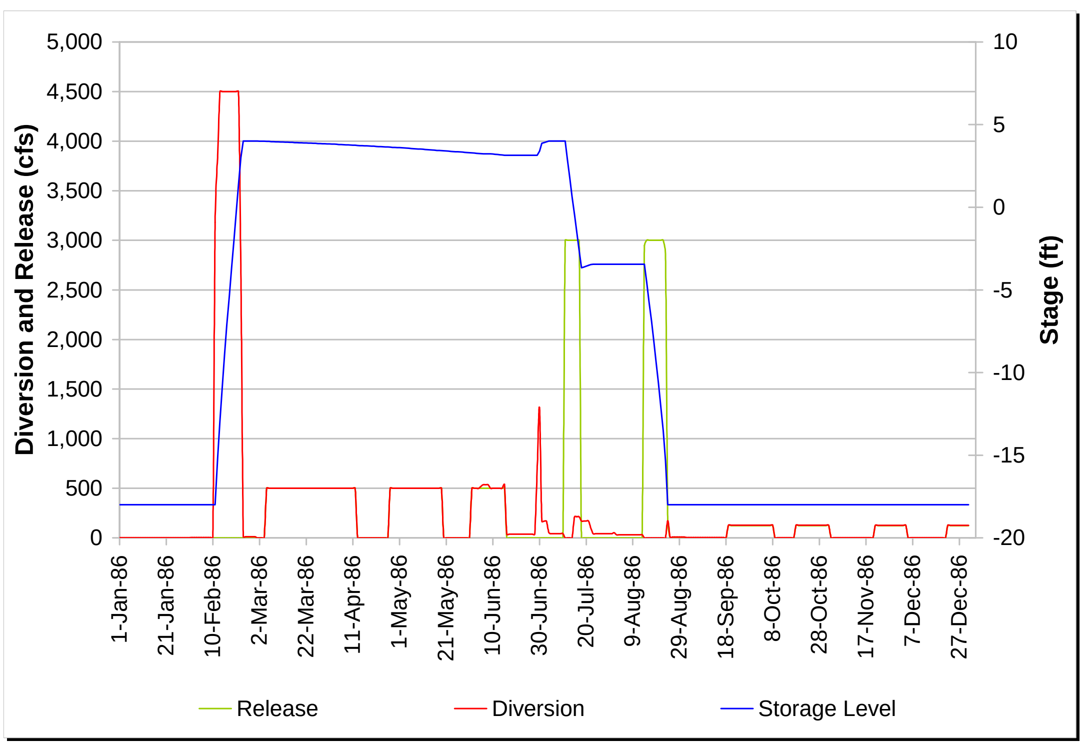


Figure 5.26: Webb Tract Operations in Wet Year (1986) - Study 4b 500

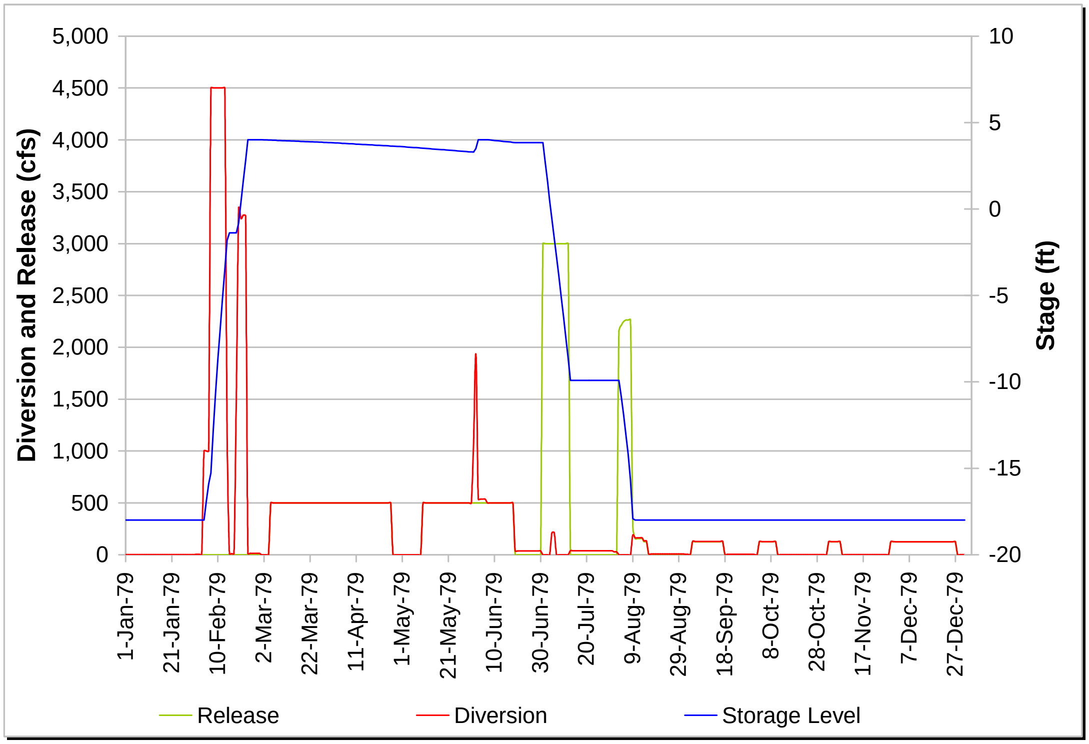


Figure 5.27: Webb Tract Operations in Below Normal Year (1979) - Study 4b 500

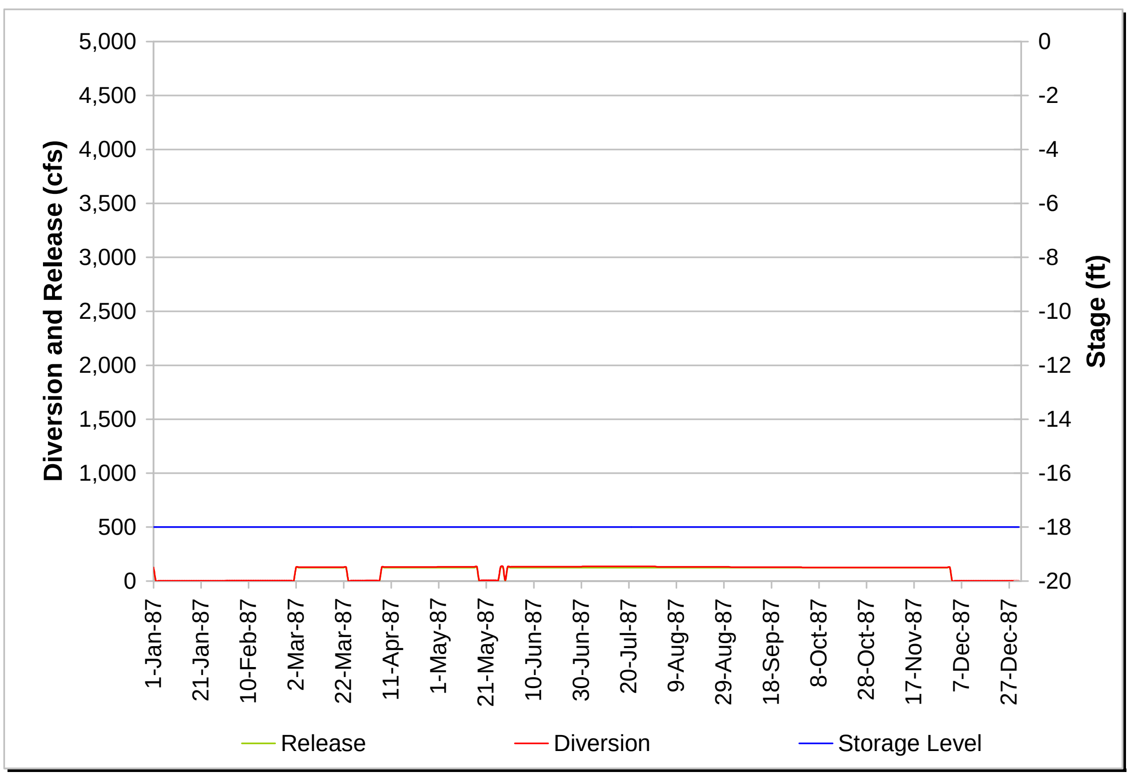


Figure 5.28: Webb Tract Operations in Dry Year (1987) - Study 4b 500

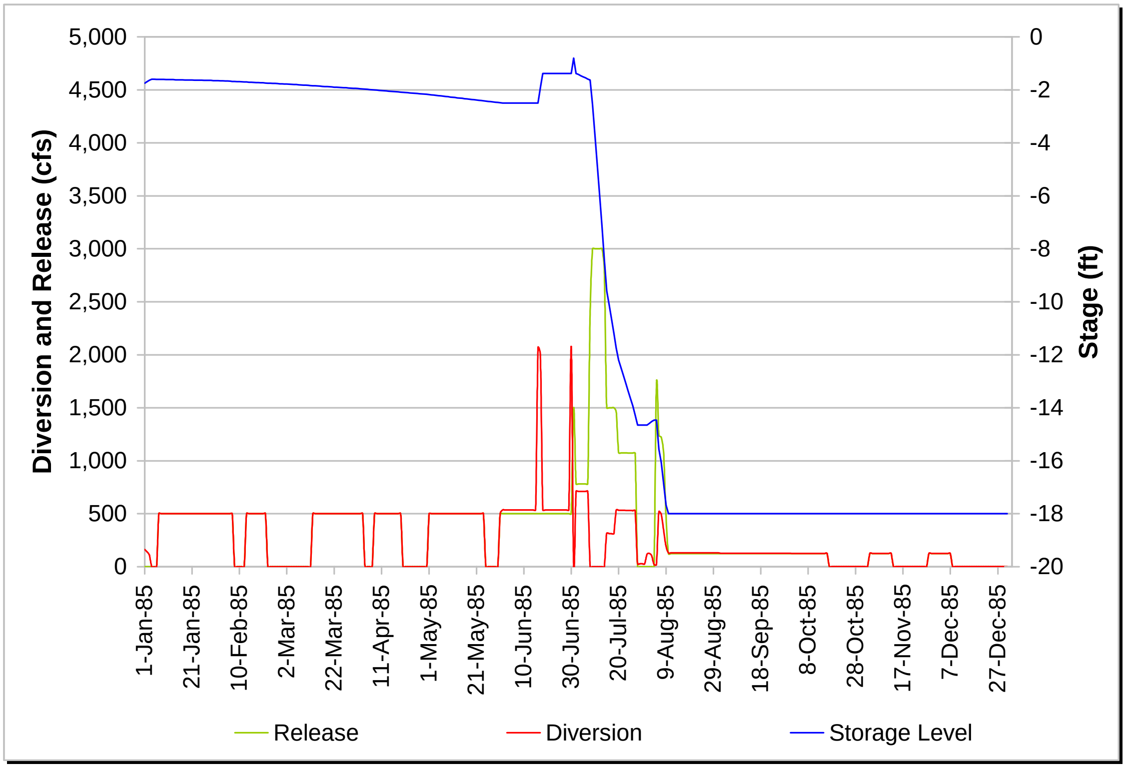


Figure 5.29: Webb Tract Operations in Dry Year (1985) - Study 4b 500

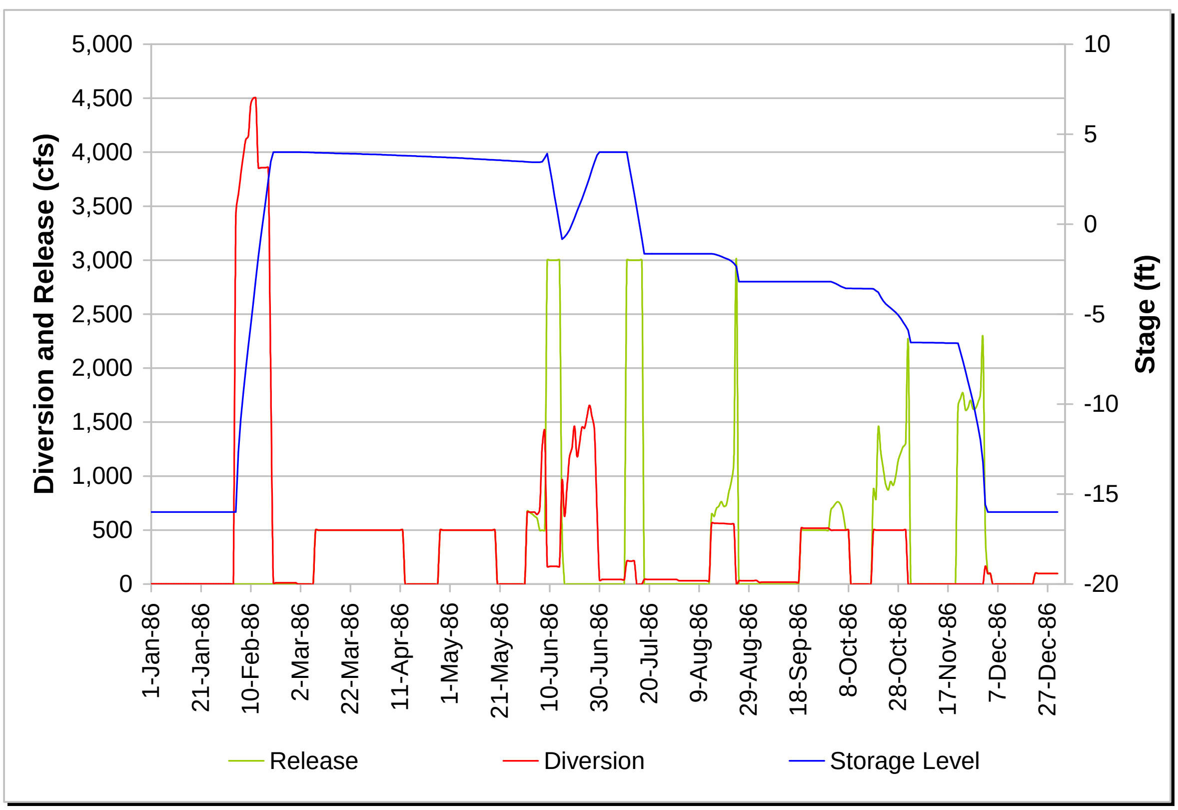


Figure 5.30: Bacon Island Operations in Wet Year (1986) - Study 4b 500

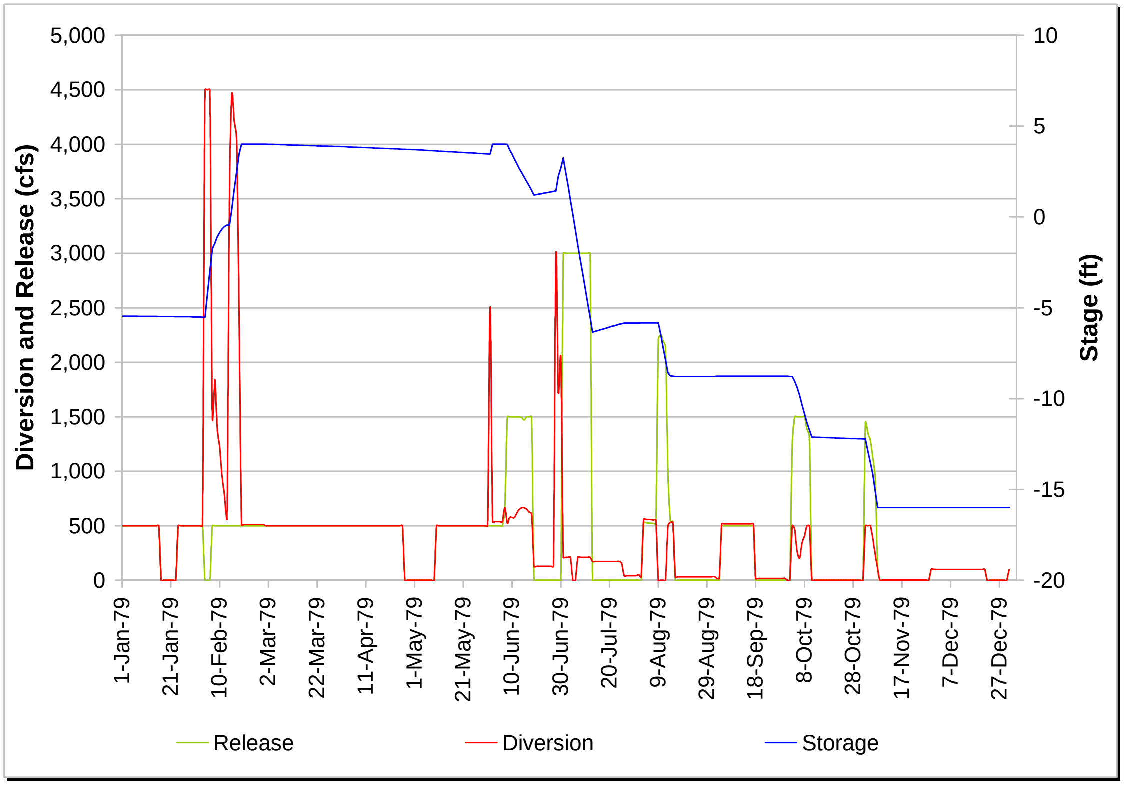


Figure 5.31: Bacon Island Operations in Below Normal Year (1979) - Study 4b 500

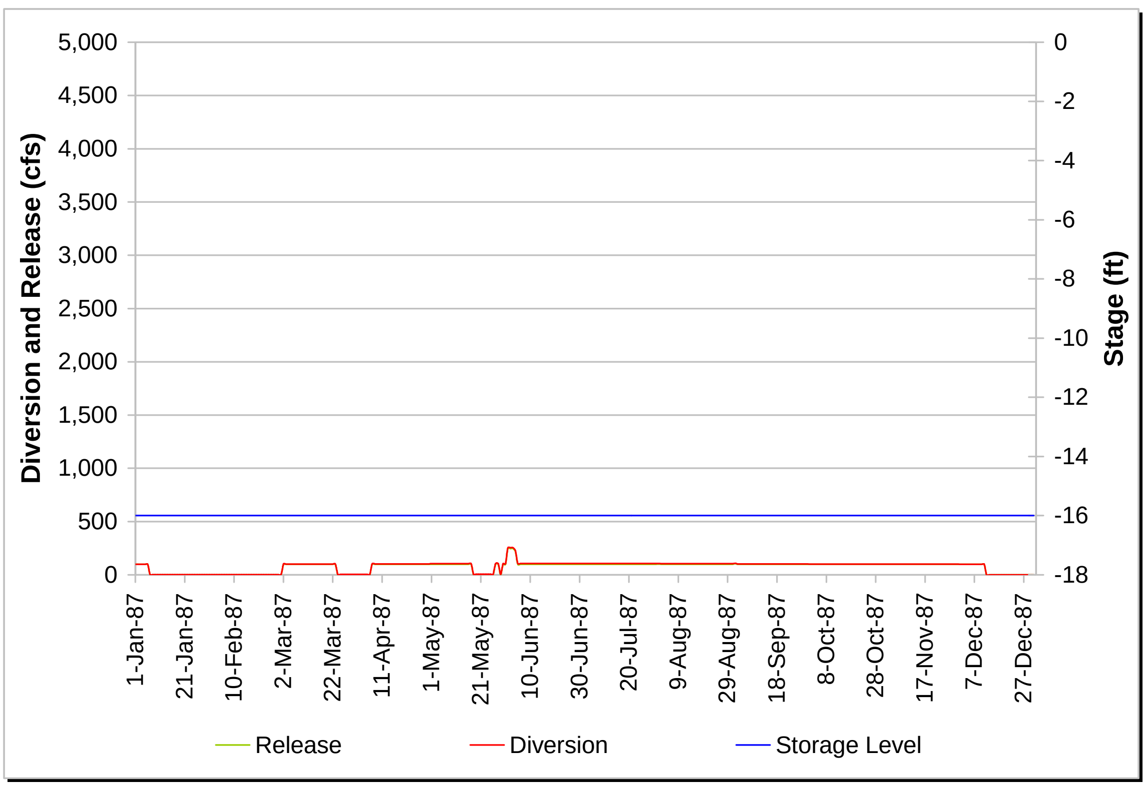


Figure 5.32: Bacon Island Operations in Dry Year (1987) - Study 4b 500

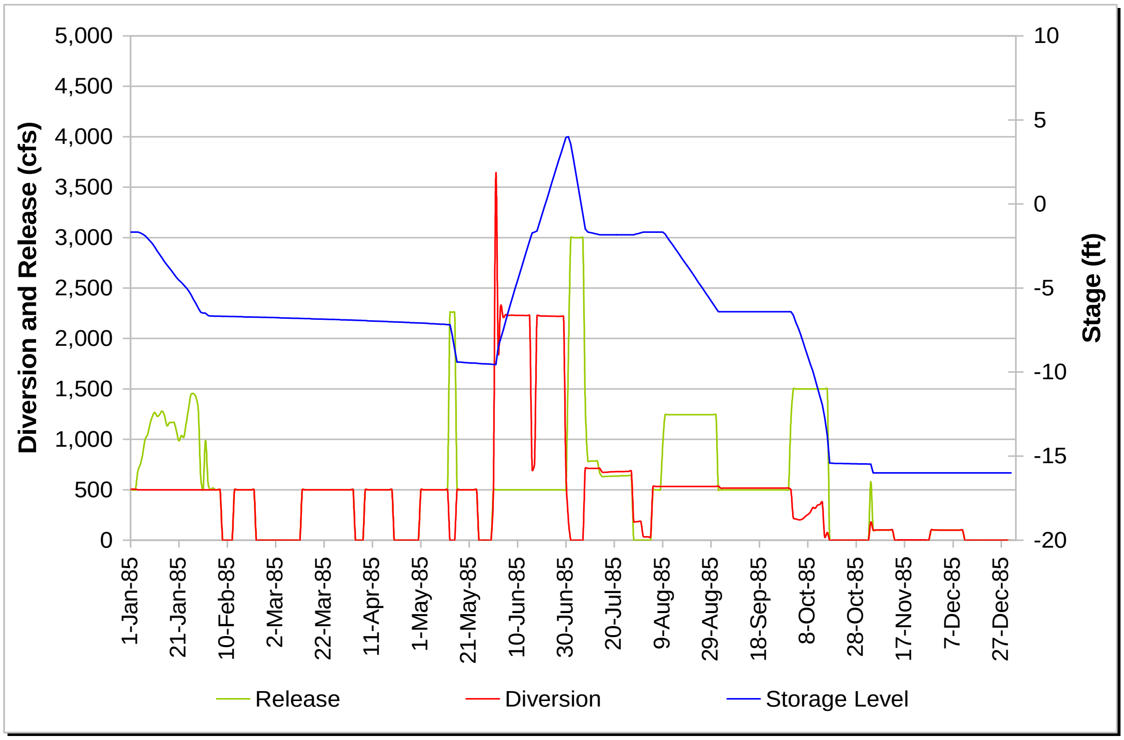


Figure 5.33: Bacon Island Operations in Dry Year (1985) - Study 4b 500

Organic Carbon Operations: Organic carbon (DOC) operations for a wet year (1986), below normal year (1979), and a dry (1987) are presented in Figures 5.34 through 5.42 for Banks, Tracy and Contra Costa's Intake. These figures show OC standards and base DOC at the specified location. They also show DOC from the reservoir releases and 14-Day average DOC due to island operations at the specified location for both Study 4a and 4b. A general discussion of these results is presented below.

The results indicate that In-Delta Storage operations, both with and without circulation, stay within the required DOC standards at the export locations from January through June of typical wet and below normal years. From June through December of typical wet, below normal and dry years, the DOC standards are periodically exceeded. Without circulation, the standards are exceeded by up to 1.5 mg/l at Banks, 1 mg/l at Tracy and 2 mg/l at Contra Costa in typical wet and below normal years and by up to 3 mg/l at Banks, 2 mg/l at Tracy and 2 mg/l at Contra Costa in typical dry years.

Circulation operations significantly reduce the amount of DOC coming off the reservoir islands, reducing the overall DOC impact at the export locations. With circulation operations, the standards are found to be exceeded by only up to a maximum of 1 mg/l at Banks, 0.5 mg/l at Tracy and 1 mg/l at Contra Costa in typical wet and below normal years and are rarely exceeded by no more than 0.5 mg/l in typical dry years. As a result of this, the overall water supply impact of operating under the required standards is reduced by up to 10 taf/year on average.

These results indicate that circulation can work as a tool to help resolve potential DOC problems encountered by In-Delta Storage operations. There may be additional ways to operate in a way to further reduce DOC impacts, but this method shows that the issue can be resolved. Further operational studies can be conducted to refine In-Delta Storage operations.

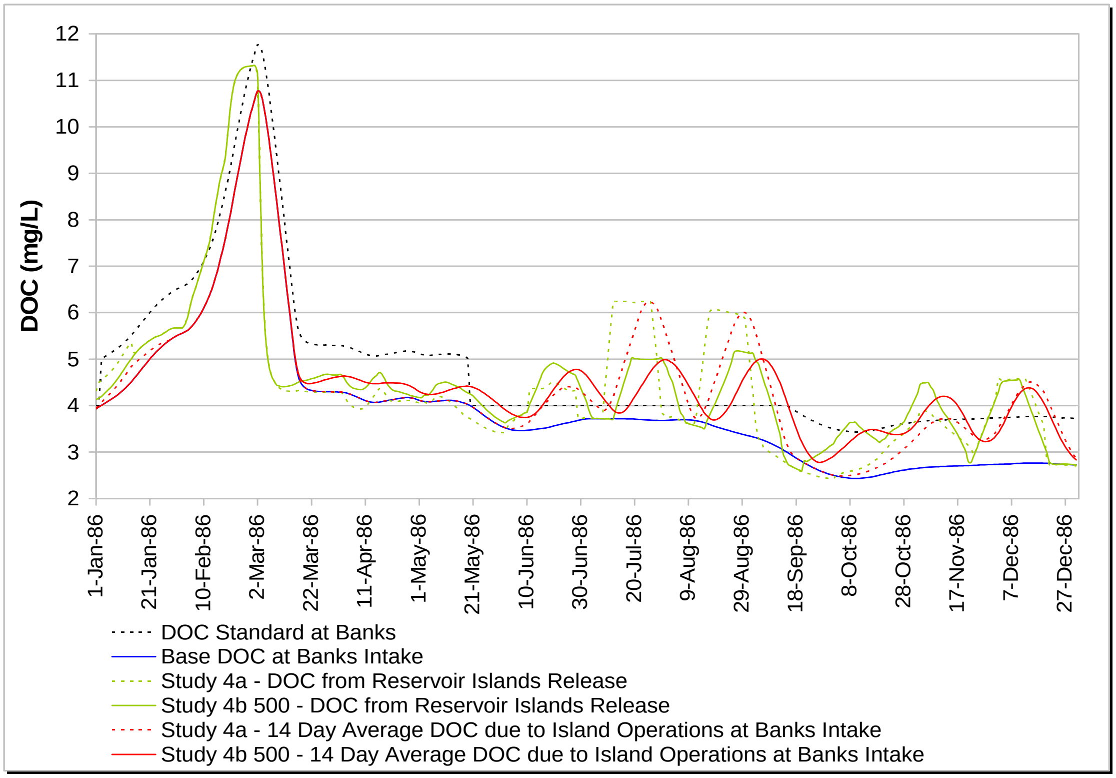


Figure 5.34: Organic Carbon Operations at Banks in Wet Year (1986)

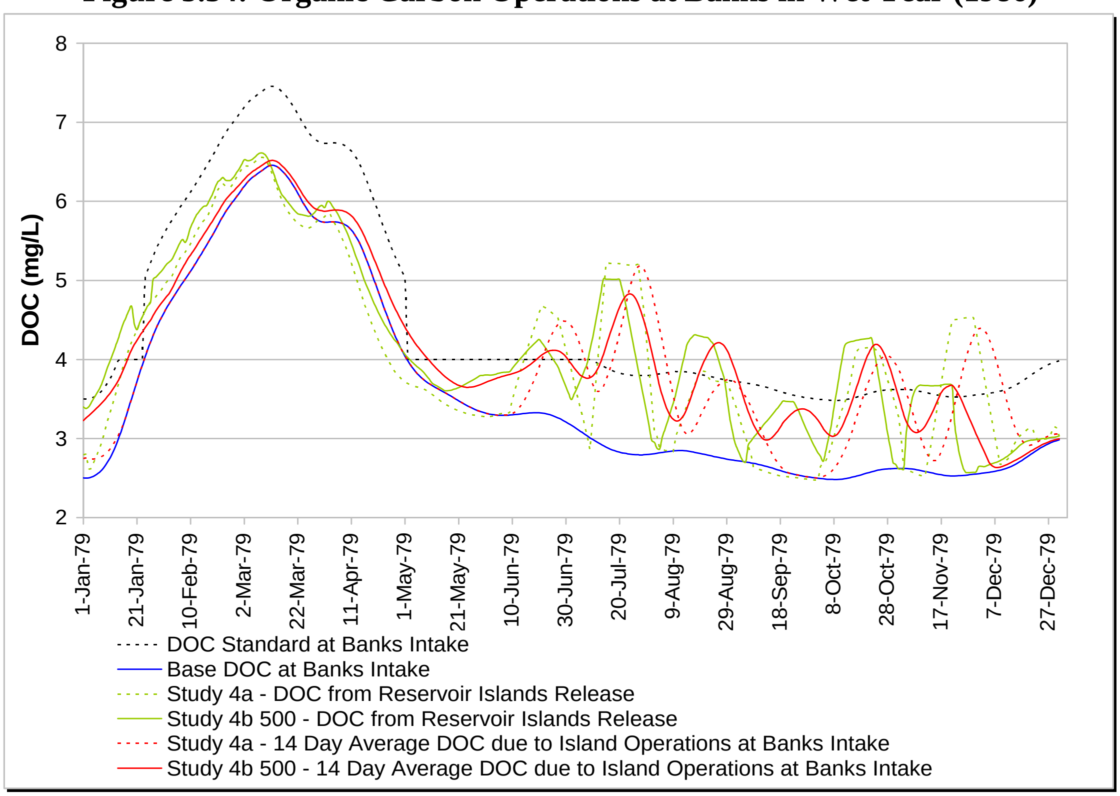


Figure 5.35: Organic Carbon Operations at Banks in Below Normal Year (1979)

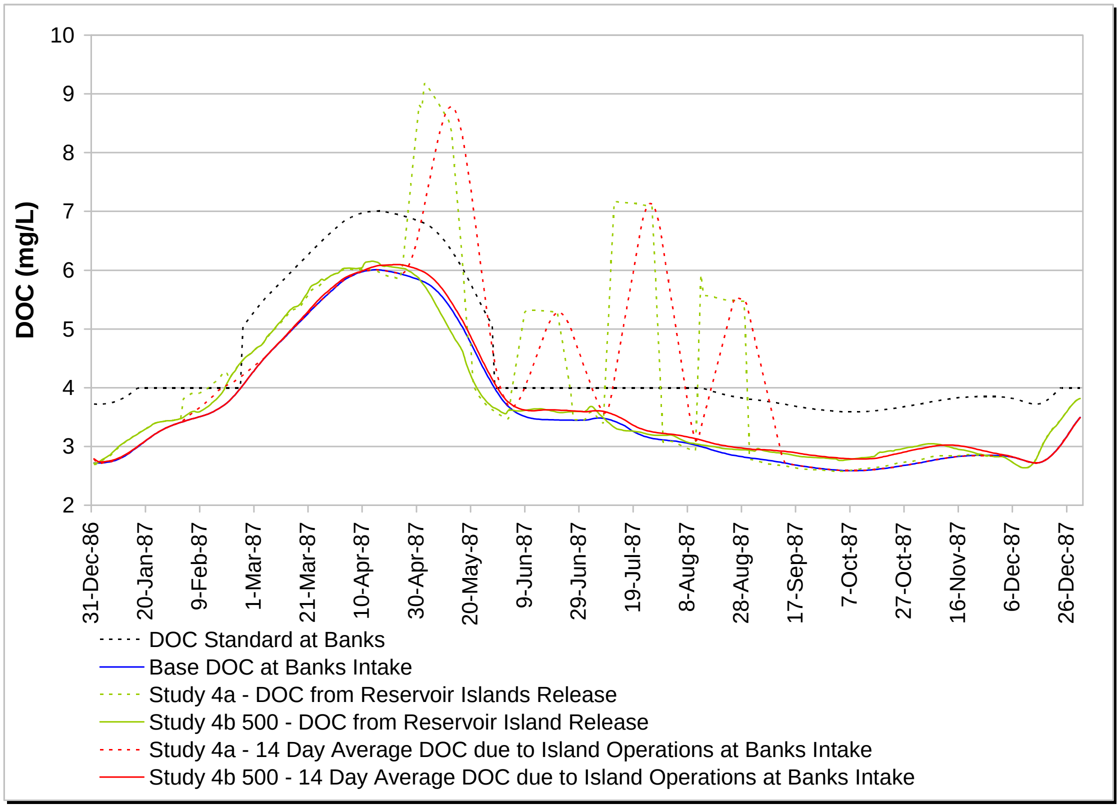


Figure 5.36: Organic Carbon Operations at Banks in Dry Year (1987)

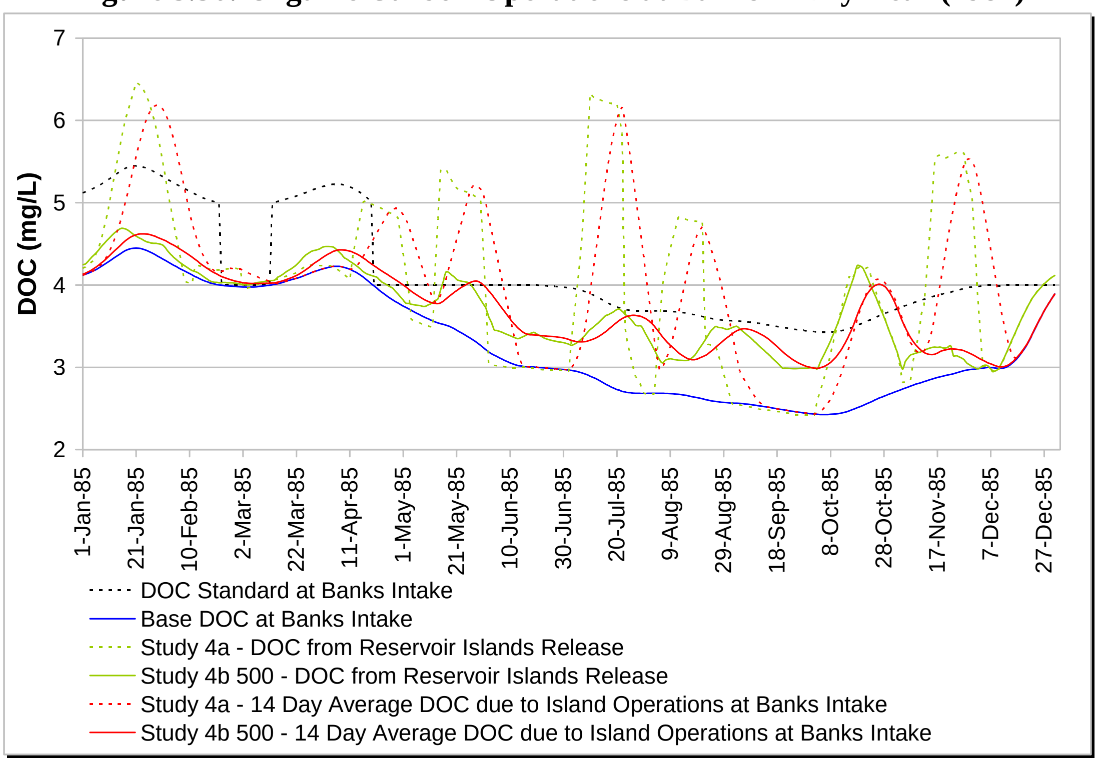


Figure 5.37: Organic Carbon Operations at Banks in Dry Year (1985)

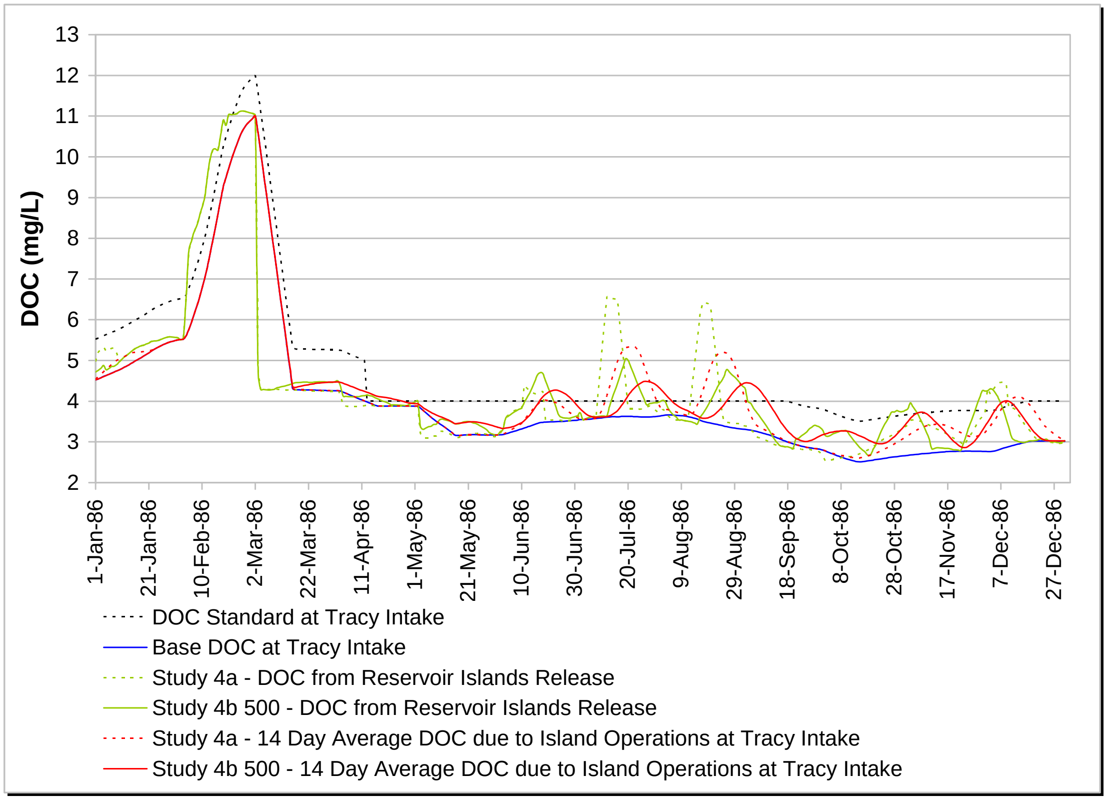


Figure 5.38: Organic Carbon Operations at Tracy in Wet Year (1986)

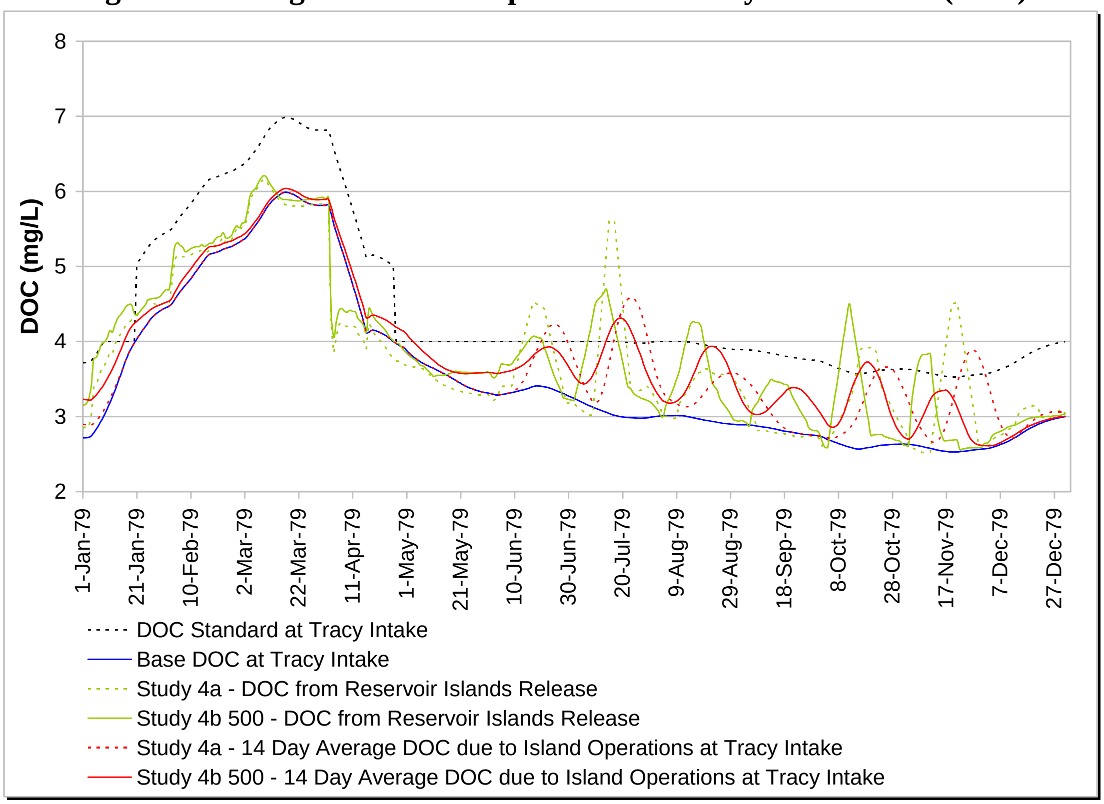


Figure 5.39: Organic Carbon Operations at Tracy in Below Normal Year (1979)

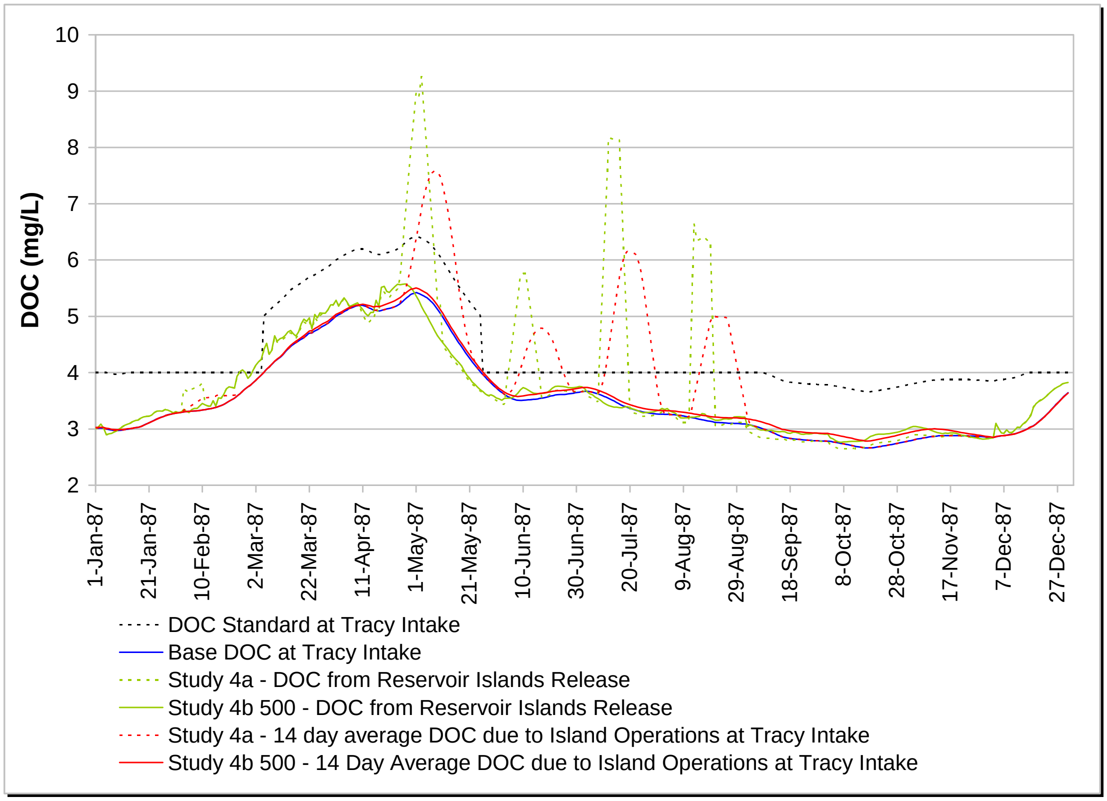


Figure 5.40: Organic Carbon Operations at Tracy in Dry Year (1987)

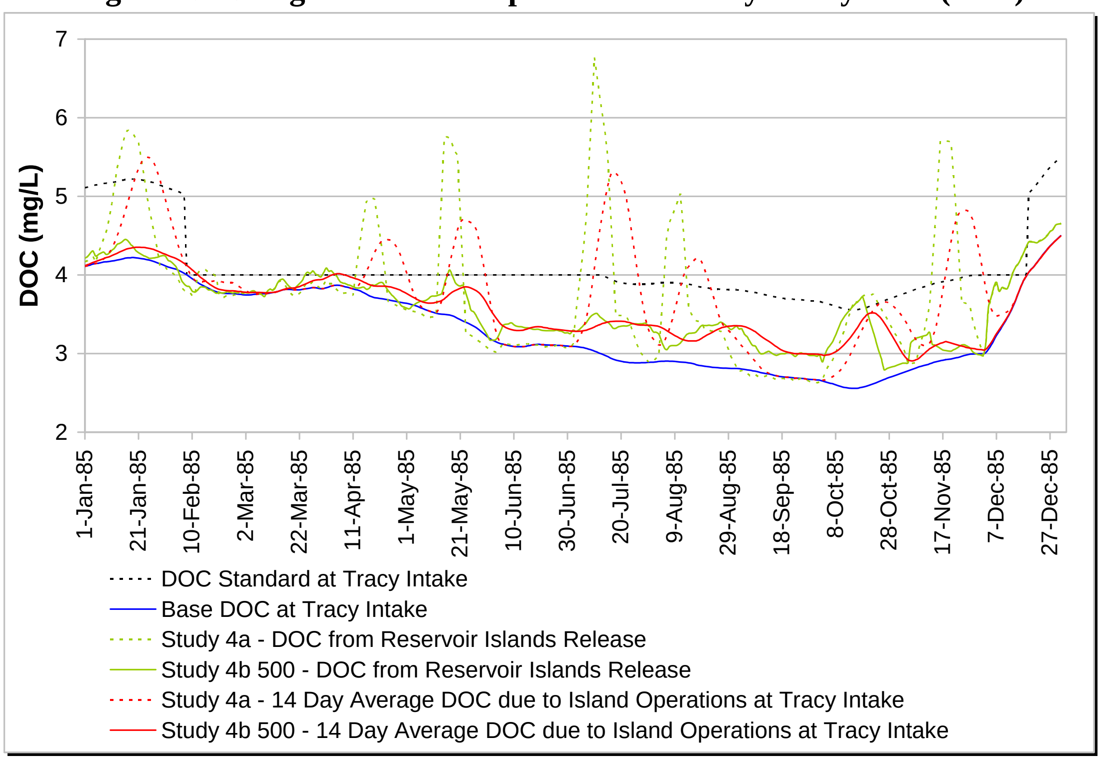


Figure 5.41: Organic Carbon Operations at Tracy in Dry Year (1985)

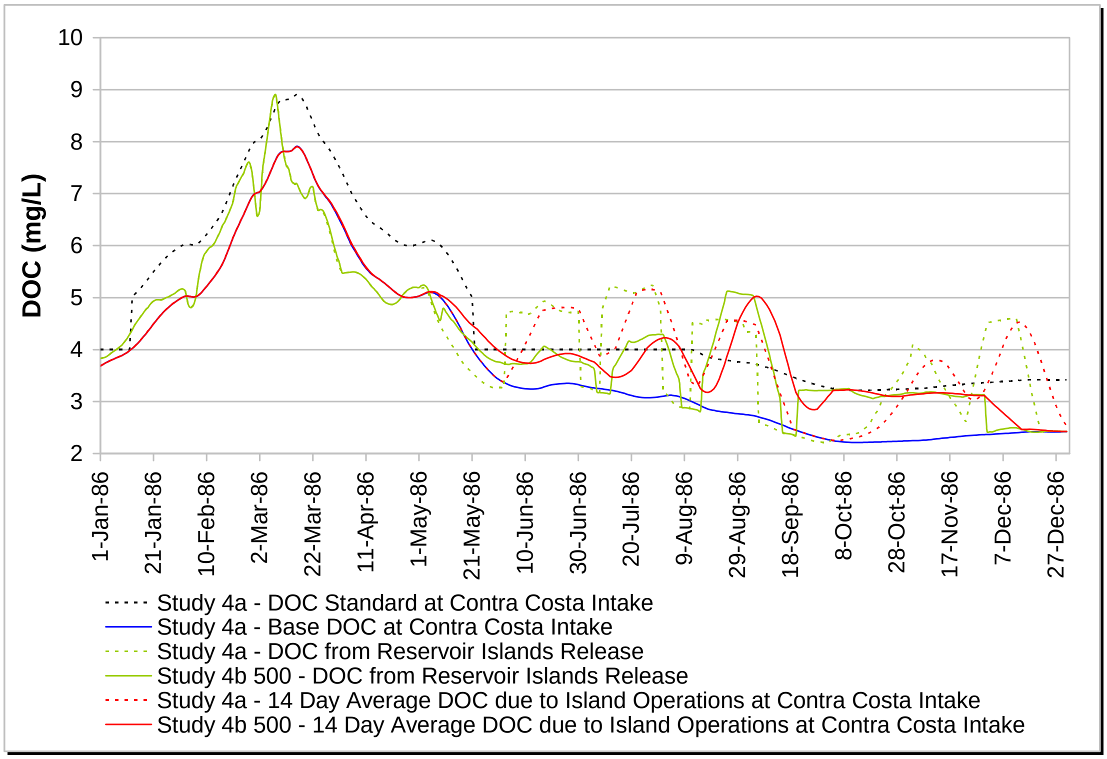


Figure 5.42: Organic Carbon Operations at Contra Costa Intake in Wet Year (1986)

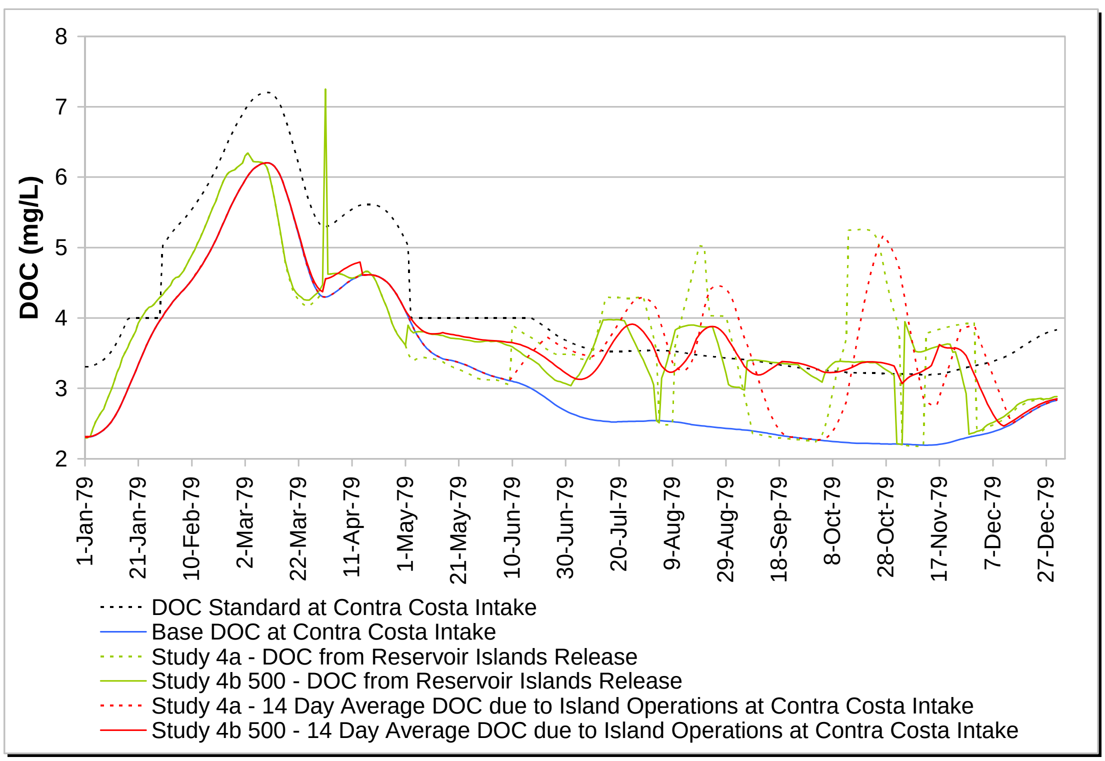


Figure 5.43: Organic Carbon Operations at Contra Costa in Below Normal Year (1979)

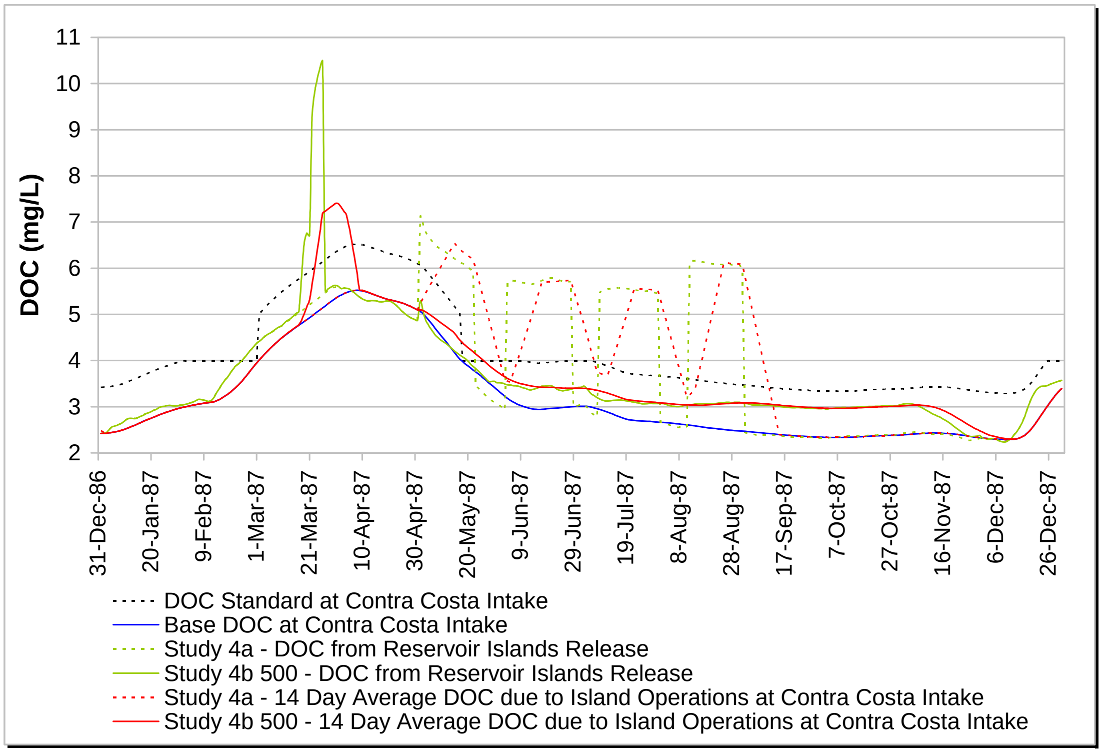


Figure 5.44: Organic Carbon Operations at Contra Costa Intake in Dry Year (1987)

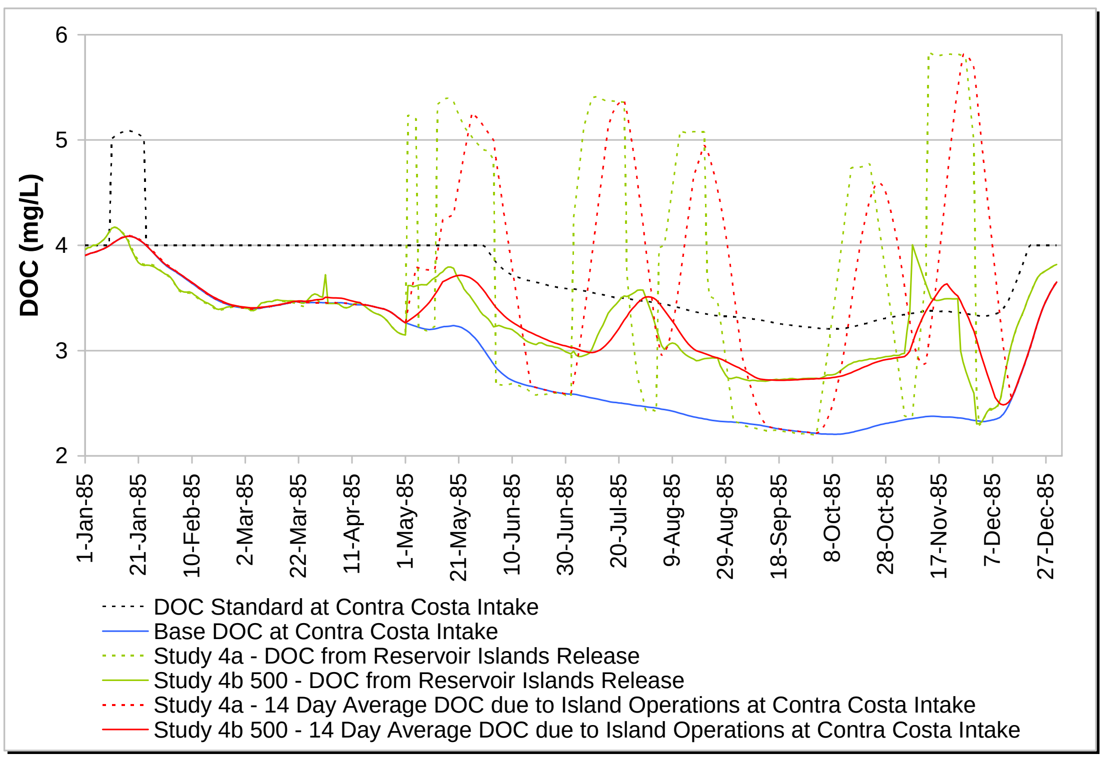


Figure 5.45: Organic Carbon Operations at Contra Costa Intake in Dry Year (1985)

5.4.3 Assessment of Fish and Aquatic Habitat Protections

The In-Delta Storage project's location is unique and allows swift action to be taken to respond to instream flow requirements for fish and aquatic habitat. Seasonal timing and magnitude of water diversions from the Delta may affect aquatic species directly through entrainment and impingement or indirectly through changes in hydrologic conditions and aquatic habitat.

Results of operational studies indicate water stored during wet years in the Delta and additional carryover as a result of new storage can be used for fish and aquatic habitat improvements. There would be an increase in channel organic carbon close to the reservoir outlets that could benefit channel fisheries habitat. These ecological benefits need further evaluation.

Environmental water allocations during February through June and the resulting decreases in SWP exports would reduce the frequency and magnitude of reverse flows in the lower San Joaquin River. This would also contribute to the X2 position being located more within the western Delta, and increase Delta outflow. As a result, the quality and availability of aquatic habitat for fish would be improved. Additional water stored in the In-Delta Storage reservoir islands could be used to meet the ERP requirements.

When there is a significant decline in delta smelt abundance (FMWT < 239) during drought or extreme dry conditions, In-Delta Storage reservoir operations could help meet environmental needs. In-Delta Storage operations may result in additional upstream carryover storage, which can be used to release water to increase Delta outflow. Using In-Delta Storage to release water for ERP will also increase Delta outflow. Coordination between the fisheries regulatory agencies and project operators will be required to make supplies available for fisheries and habitat restoration during such extreme conditions.

5.4.4 Impact of Climate Change

Climate change may result in higher winter flows and reduced spring runoff. Operation studies indicate that effect of climate change on In-Delta Storage operations would result in marginal change in water supplies (see Figure 5.46).

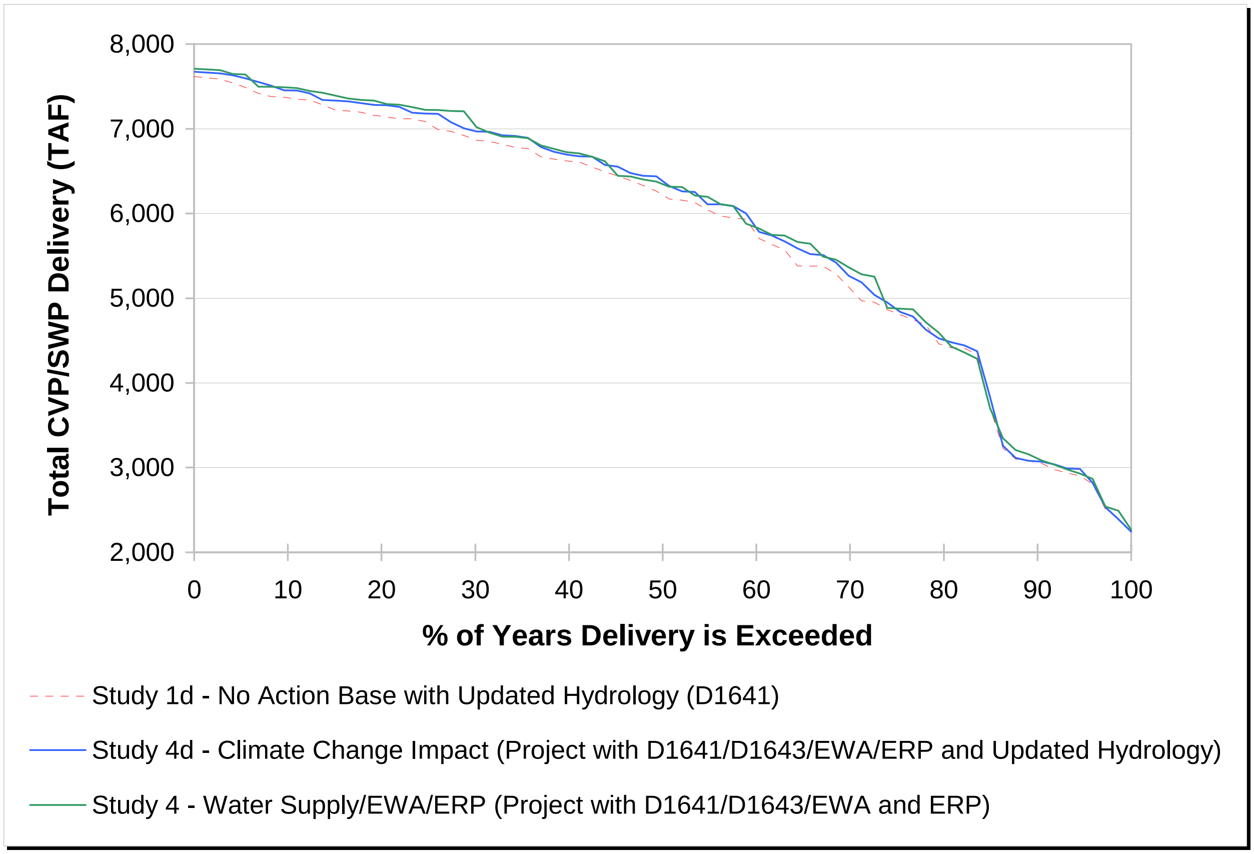


Figure 5.46: Long-Term Average Annual SWP/CVP Deliveries with Climate Change

5.4.5 Coordination with Los Vaqueros Expanded Reservoir

The study results indicate that the Los Vaqueros Reservoir Expansion Project will have minimal impact on IDS operations.

5.4.6 Impact of D1643 Actions

Other storage projects being studied for the Bay-Delta Program have not yet progressed far enough in the process to have their own assigned operational requirements similar to D1643 for In-Delta Storage. Figure 5.47 shows that the In-Delta Storage Project could deliver about 100,000 acre-feet more benefits if it was not required to operate under the D1643 contraint.

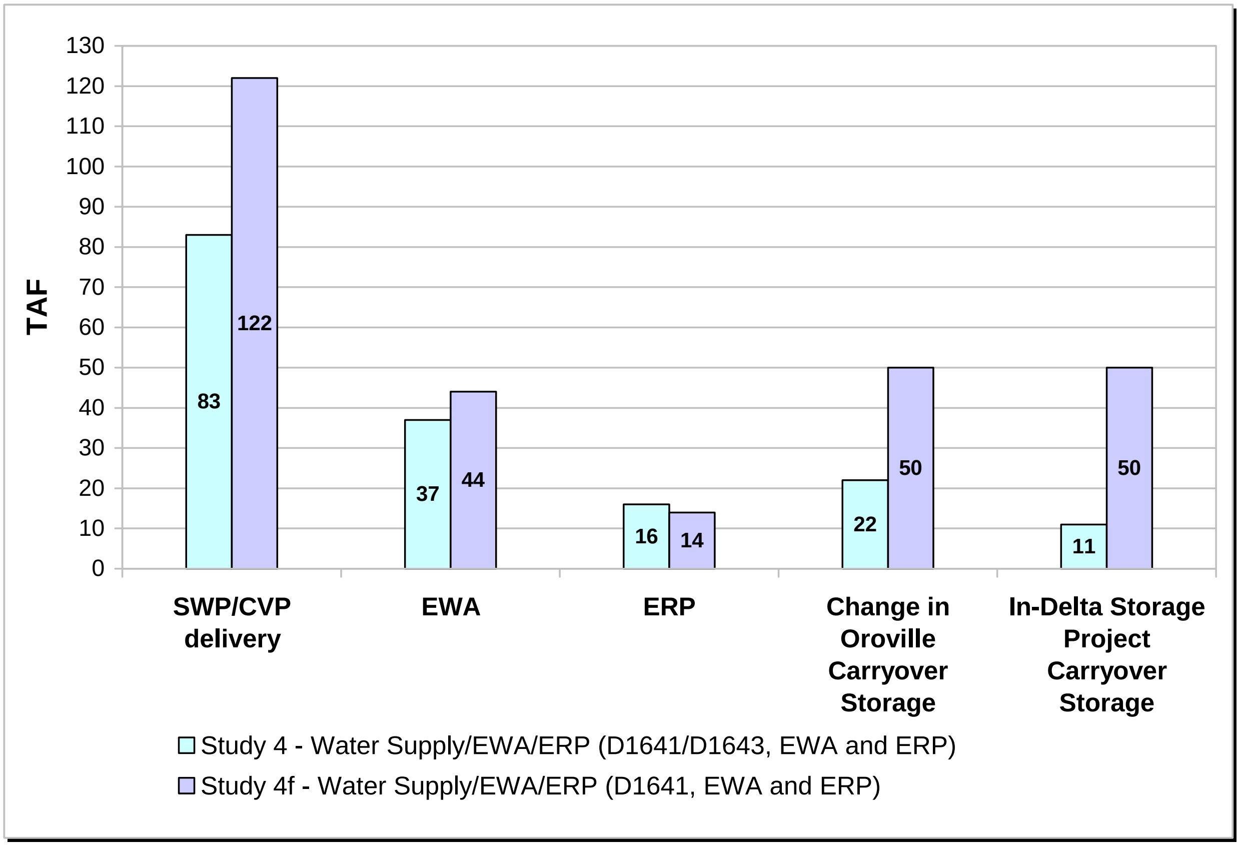


Figure 5.47: Long-Term Average Annual Changes in Water Supply

5.5 Conclusions and Recommendations

The analyses presented in this chapter included the affects of adding the In-Delta Storage Project facilities to the SWP/CVP system (with varying operations, such as the inclusion of EWA and ERP). Also presented were the impacts of: applying DOC constraints to the project; applying fisheries regulations; climate change; coordinated operation with expanded Los Vaqueros Reservoir; and SWRCB D1643.

Based on the results of the operational scenarios, the following conclusions have been made for the In-Delta Storage Project:

- Due to the project's strategic location, the operation of the island reservoirs would produce additional water deliveries to urban and agricultural water users and contribute to operational flexibility and increased reliability of the SWP and CVP systems.
- Resolution of water quality issues is possible with circulation of water through the island reservoirs.
- Future operations can be refined during consultations with regulatory agencies for improvements in habitat quality and availability for fish and other aquatic organisms inhabiting the Bay-Delta system. The timing of environmental water allocations would be flexible depending on the specific environmental benefit to be achieved (e.g. protection of spring-run chinook salmon and delta smelt).

- Due to the possibility of increased carryover storage in the upstream SWP and CVP reservoirs as a result of storing water in the Delta, CALFED's ERP and storage programs should work closely with regulatory agencies to maximize the program benefits and assure compliance of the Endangered Species Act.
- EWA studies for the In-Delta Storage Project show that In-Delta Storage could provide water needed to support the EWA program, enhancing the EWA ability to respond to real-time fisheries needs and eliminating the need to purchase a substantial portion of water, from other sources, needed by EWA each year.
- The In-Delta Storage Project and the Los Vaqueros Expansion Project were modeled, and evaluation indicates that both projects can be operated in coordination. Further evaluation of shared diversion points would result in additional benefits and cost savings. Comparative information on the other three CALFED storage programs (Shasta Enlargement, North of Delta Offstream Storage and Storage in the upper San Joaquin River Basin) could not be completed within the time limits of this study. Comparative information on all storage programs based on daily modeling is required to evaluate the benefits of joint operations. As these projects are at different levels of study, evaluations should be made based on common assumptions and overall benefit choices are to be defined.

Appendix A - SWRCB Water Right Decision 1643

A.1 Diversion Criteria

- Diversion to storage could only occur when Delta is in excess conditions and surplus flows are available.

- Initial diversions to DW Project shall not be made for the current water year (commencing October 1) until X2 has been west of Chipps Island (75 km upstream of the Golden Gate Bridge) for a period of ten (10) consecutive days. After initial X2 condition is met, diversions shall be limited to a combined maximum rate of 5,500 cfs for five (5) consecutive days.

- Maximum rate of diversion onto either Webb Tract or Bacon Island would be 4,500 cfs (9taf/day). The combined maximum daily average rate of diversion for all islands (including diversions to habitat islands) will not exceed 9,000 cfs.

- The maximum annual amount diverted to Webb Tract storage shall not exceed 155 taf per year from January 1 to March 31 and June 1 to December 31 and shall not exceed 106,900 af per year from December 15 to March 31. The total amount of water taken from all sources shall not exceed 417 taf per water year of October 1 to September 30.

- The maximum annual amount diverted to Bacon Island storage shall not exceed 147 taf per year from January 1 to March 31 and June 1 to December 31 and shall not exceed 110,570 AF from December 15 to March 31. The total amount of water taken from all sources shall not exceed 405 taf per water year of October 1 to September 30.

- Diversions shall not exceed 1000 cfs when the 14-day running average of X2 is farther than 80 km upstream of the Golden Gate Bridge, nor exceed 500 cfs if the 14-day running average of X2 is farther than 81 km upstream of the Golden Gate Bridge.

- No Diversions to storage will be made if the Delta is in excess conditions and such diversions cause the location of the 14-day running average of X2 to shift upstream (east) such that X2 is:
  - East of Chipps Island (75 river kilometers upstream of the Golden Gate Bridge) during the months of February through May, or
  - East of Collinsville (81 kilometers upstream of the Golden Gate Bridge) during the months of January, June, July, and August, or
  - During December, east of Collinsville and delta smelt are present at Contra Costa Water District's point of diversion under Water Right Permits 20749 and 20750.

- In the period from September through March DW shall not divert water to storage when X2 is located upstream of Collinsville salinity gauge.

- In the period from October through March, DW Project shall not divert water to storage if the effect of DW Project diversions would cause an upstream shift in the X2 position in excess of 2.5 km (i.e., increase the X2 by 2.5 km).

- In the period from April through May, DW Project shall not divert water to storage.

- If the delta smelt FMWT index is less than 239 (FMWT<239), DW shall not divert water for storage from February 15 through June 30.

- DW Project diversions to storage shall not exceed the following percentage of the available surplus water if FMWT Index > 239:

Month	OCT- JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG- SEP
Diversion (%)	90	75	50	0	0	50	75	90

- If FMWT < 239, DW Project diversions to storage shall not exceed the following percentage of the available surplus water:

Month	OCT-JAN	FEB(1-14)	FEB(15-28)-JUNE	JUL	AUG-SEP
Diversion (%)	90	75	NA	75	90

- DW Project diversions to storage shall not exceed a percentage of the previous day's net Delta outflow rate (assume FMWT Index > 239 scenario):

Month	OCT-DEC	JAN-MAR	APR	MAY	JUN-SEP
Diversion (%)	25	15	0	0	25

- If FMWT<239, DW Project diversions to storage shall not exceed a percentage of the previous day's net Delta outflow rate:

Month	OCT- DEC	JAN-FEB(14)	FEB(15-28) -JUN	JUL-SEP
Diversion (%)	25	15	NA	25

- In the period from December through March, DW Project Diversions to storage shall not exceed the percentage of the previous days San Joaquin River inflow rate.

- If FMWT Index > 239, this limit applies for 15 days during the December through March period whenever DW Project diverts water to storage.

Month	DEC	JAN	FEB	MAR
Diversion (%)	125	125	125	50

- If FMWT Index < 239, this limit applies for 30 days during the December through March period whenever DW Project diverts water to storage.

Month	DEC	JAN	FEB(1-14)	FEB(15-28)	MAR

Diversion (%)	125%	100%	50%	NA	NA

- For the month of March diversion to DW Project shall be reduced to 550 cfs in unless QWEST remains positive.

- Reduce diversion rate to 50% of the previous day's diversion rate during the presence of delta smelt.

- In the period from November through January, when the Delta Cross Channel gates are closed, DW Project shall limit diversions to storage as follows:

Delta Inflow	Maximum Combined Diversion Rate
<=30,000 cfs	3,000 cfs
<=50,000 cfs & >30,000 cfs	4,000 cfs

- Water will be diverted onto Bacon Island and Webb Tract from June through October in order to offset actual reservoir losses of water stored on those islands, referred to as "topping-off" reservoirs. Topping-off diversions shall not exceed the following maximum diversion rate (cfs) and maximum monthly quantity (taf) listed below:

Month	JUN	JUL	AUG	SEP	OCT
Maximum diversion rate (cfs)	215	270	200	100	33
Maximum monthly quantity (taf)	13	16	12	6	2

The maximum topping-off diversion rates shown above shall be further limited by diversions onto the habitat islands. The maximum topping-off diversion rate and quantity shall be reduced by an amount equal to the habitat island diversions during the same period.

- From September through May, the reservoir islands may be flooded to shallow depths (1ft) to create 200 acres of shallow water rearing and spawning habitat, typically 60 days after reservoir drawdown. After shallow water flooding, water will be circulated till deep water flooding occurs in April or May.

- The maximum rate of proposed diversion onto Holland Tract and Bouldin Island will be 200 cfs per island. Diversions onto the habitat islands will not cause the combined daily average maximum diversion rate of 9,000 cfs for all four project islands to be exceeded. Water will be applied in each month of the year

A.2 Discharge/Release Criteria

- Releases would be made at a combined maximum daily average of 9,000 cfs. Combined monthly average reservoir island discharge will be up to 4,000 cfs. Maximum annual release of stored water would be 822 taf.

- Maximum Annual export of stored water would be 250 taf.

- No discharges shall be made for export from Webb Tract from January through June.

- In the period from April through June, DW shall limit discharges for export from Bacon Island to 50% of the San Joaquin inflow measured at Vernalis.

- DW shall not discharge for export any water from the habitat islands.

- Reduce the discharge for export rate to 50% of previous day's diversion rate during the presence of delta smelt.

- DW Project discharge is subject to export limits, treated as an export in the monthly E/I ratio computation except when water is discharged for environmental water account.

- In the period from February through July, DW discharges for export shall be limited to the following percentage of the available unused export capacity at the CVP and SWP facilities:

Month	FEB	MAR	APR	MAY	JUN	JUL
Discharge (Bacon Island	75%	50%	50%	50%	50%	75%
Discharge (Webb Tract)	NA	NA	NA	NA	NA	75%

- DW shall reduce the discharge for export rate to 50% of the previous day's diversion rate during the presence of delta smelt.

A.3 Water Quality Criteria

A.3.1 Salinity

- Project Operations should not cause an increase in salinity or more than 10 mg/L chloride at one or more of the urban intakes: or
- Project Operations should not cause any salinity increase at the urban intakes in the Delta exceeding 90% of an adopted salinity standard (e.g., Rock Slough chloride standard defined in SWRCB Decision 1641Total Trihalomethanes (“TTHM”) concentrations in-excess of 64 μg/L at the urban intakes in the delta.

A.3.2 Total Organic Carbon

The project operation shall not cause or contribute to total organic carbon (TOC) concentrations that will violate either of the following criteria:

- Increase in TOC concentration at a SWP, CVP, CCWD pumping plant, or at a receiving water treatment plant that will cause the limit of 4.0 mg/L to be exceeded;
- Incremental increase in TOC concentration at a SWP, CVP, or CCWD pumping plant of greater than 1.0 mg/L (14-day average) (SWRCB, condition 14.b.).

Note: In this study DOC was used as a surrogate for TOC.

Appendix B – Modeling Assumptions

The assumptions for the future No-Action Base study and “with project” operational scenarios are summarized in Table B.1.

Table B.1: CALSIM Operational Assumptions

	Study 1: No-Action Base Alternative	Study 2: Water Supply	Study 3: Water Supply/EWA	Study 4: Water Supply/EWA/ERP
Period of Simulation	73 years (1922-1994)	Same	Same	Same
HYDROLOGY				
Level of Development (Land Use)	2020 Level	Same	Same	Same
Demands				
North of Delta (exc American R)				
CVP (non-settlement)	Land Use based, limited by Full Contract	Same	Same	Same
(Settlement)	Land Use based, historical	Same	Same	Same
SWP (FRSA)	Land Use based, limited by Full Contract	Same	Same	Same
Non-Project	Land Use based (may adjust as a result of conservation)	Same	Same	Same
CVP Refuges	Level 2	Level 4	Level 4	Level 4
American River Basin				
Water rights	Alt 2 formulation of AR Contract Renewal EIS (may adjust as a result of conservation)	Same	Same	Same
CVP	Alt 2 formulation of AR Contract Renewal EIS (may adjust as a result of conservation)	Same	Same	Same
San Joaquin River Basin				
Friant Unit	Regression of historical	Same	Same	Same
Lower Basin	Fixed annual demands	Same	Same	Same
Stanslaus River Basin	New Melones Interim Operations Plan[1]	Same	Same	Same
South of Delta				
CVP	Full Contract (3.3 maf / yf)	Same	Same	Same
CCWD	195 taf / yr	Same	Same	Same
SWP (w/ North Bay Aqueduct)	3.3-4.1 maf / yr (may adjust for conservation, recycle, desal)	Same	Same	Same
Article 21	MWDSC - up to 50 taf / mon (Dec-Mar), Others - up to 84 taf / mon	Same	Same	Same
Kern Water Bank Recharge				

[1] Because a new operating plan has not been determined, the interim plan is the default plan for future no-action conditions.

	Study 1: No-Action Base Alternative	Study 2: Water Supply	Study 3: Water Supply/EWA	Study 4: Water Supply/EWA/ERP
Recharge for Kern County ground water overdraft	Not Included	Recharge rate not to exceed 1,600 cfs	Recharge rate not to exceed 1,600 cfs	Recharge rate not to exceed 1,600 cfs
FACILITIES				
System-wide	Existing Facilities (2001)	Same	Same	Same
Upper American River	PCWA pumps[2]	Same	Same	Same
REGULATORY STANDARDS				
Trinity River				
Minimum Flow below Lewiston Dam	Trinity EIS Preferred Alternative (369-815 taf / yr)	Same	Same	Same
Trinity Reservoir End-of-September Minimum Storage	Trinity EIS Preferred Alternative (600 taf as able)	Same	Same	Same
Clear Creek				
Minimum Flow below Whiskeytown Dam	Downstream water rights, 1963 USBR Proposal to USFWS and NPS, and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same
Upper Sacramento River				
Shasta Lake End-of-September Minimum Storage	Be Consistent with OCAP assumptions on Upper Sacramento River regulatory standards. (SWRCB WR 1993 Winter-run Biological Opinion (1900 TAF))	Same	Same	Same
Minimum Flow below Keswick Dam	Be Consistent with OCAP assumptions on Upper Sacramento River regulatory standards. (Flows for SWRCB WR 90-5 and 1993 Winter-run Biological Opinion temperature control, and USFWS discretionary use of CVPIA 3406(b)(2))	Same	Same	Same
Feather River				
Minimum Flow below Thermalito Diversion Dam	1983 DWR, DFG Agreement (600 CFS)	Same	Same	Same
Minimum Flow below Thermalito Afterbay outlet	1983 DWR, DFG Agreement (1000 – 1700 CFS)	Same	Same	Same
Yuba River				
Minimum Flow	SWRCB D-1644	Same	Same	Same
American River				
Minimum Flow below Nimbus Dam	Be Consistent with OCAP assumptions on American River regulatory standards.	Same	Same	Same

[2] The Placer County Water Agency facility is just about to begin construction – pumps in American River upstream of Folsom

	Study 1: No-Action Base Alternative	Study 2: Water Supply	Study 3: Water Supply/EWA	Study 4: Water Supply/EWA/ERP
	(SWRCB D-893 (see accompanying Operations Criteria), and USFWS discretionary use of CVPIA 3406(b)(2)			
Minimum Flow at H Street Bridge	Be Consistent with OCAP assumptions on American River regulatory standards. (SWRCB D-893)	Same	Same	Same
Lower Sacramento River				
Minimum Flow near Rio Vista	SWRCB D-1641	Same	Same	Same
Mokelumne River				
Minimum Flow below Camanche Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (100 – 325 CFS)	Same	Same	Same
Minimum Flow below Woodbridge Diversion Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (25 – 300 CFS)	Same	Same	Same
Stanislaus River				
Minimum Flow below Goodwin Dam	1987 USBR, DFG agreement, and USFWS discretionary use of CVPIA 3406(b)(2)	Same	Same	Same
Minimum Dissolved Oxygen	SWRCB D-1422	Same	Same	Same
Merced River				
Minimum Flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180 – 220 CFS, Nov – Mar), and Cowell Agreement	Same	Same	Same
Minimum Flow at Shaffer Bridge	FERC 2179 (25 – 100 CFS)	Same	Same	Same
Tuolumne River				
Minimum Flow at Lagrange Bridge	FERC 2299-024, 1995 (Settlement Agreement) (94 – 301 TAF/YR)	Same	Same	Same
San Joaquin River				
Maximum Salinity near Vernalis	SWRCB D-1641	Same	Same	Same
Minimum Flow near Vernalis	SWRCB D-1641, and Vernalis Adaptive Management Program per San Joaquin River Agreement	Same	Same	Same
Sacrameto River-San Joaquin River Delta				
Delta Outflow Index (Flow and Salinity)	SWRCB D-1641	Same	Same	Same
Delta Cross Channel Gate Operation	SWRCB D-1641	Same	Same	Same
Delta Exports	SWRCB D-1641	Same	Same	Same
OPERATIONS CRITERIA				
Subsystem				
Upper Sacramento River				

	Study 1: No-Action Base Alternative	Study 2: Water Supply	Study 3: Water Supply/EWA	Study 4: Water Supply/EWA/ERP
Flow Objective for Navigation (Wilkins Slough)	Discretionary 3,500 – 5,000 CFS based on Lake Shasta storage condition	Same	Same	Same
American River				
Folsom Dam Flood Control	SAFCA, Operation of Folsom Dam, Variable 400/670 (with outlet modifications)	Same	Same	Same
Flow below Nimbus Dam	Discretionary operations criteria corresponding to SWRCB D-893 required minimum flow	Same	Same	Same
Sacramento Water Forum Mitigation Water	Sacramento Water Forum (up to 47 TAF/YR in dry years) – (the Wedge)	Same	Same	Same
Stanislaus River				
Flow below Goodwin Dam	1997 New Melones Interim Operations Plan	Same	Same	Same
System-wide				
CVP Water Allocation				
CVP Settlement and Exchange	100% (75% in Shasta Critical years)	Same	Same	Same
CVP Refuges	100% (75% in Shasta Critical years)	Same	Same	Same
CVP Agriculture	100% - 0% based on supply	Same	Same	Same
CVP Municipal & Industrial	100% - 50% based on supply	Same	Same	Same
SWP Water Allocation				
North of Delta (FRSA)	Contract specific	Same	Same	Same
South of Delta (including North Bay Aqueduct)	Based on supply; Equal prioritization between Ag and M&I	Same	Same	Same
Delta Pumping				
Banks pumping	8,500 cfs Oct-Mar 15, 6,680 cfs Mar 15-Jun 30, 8,000 cfs Jul, Aug & Sept.	Same	Same (500 cfs reserved for EWA in Jul, Aug and Sept.)	Same (500 cfs reserved for EWA in Jul, Aug and Sept.)
Tracy pumping	4,600 cfs (minimum of 800 cfs)	Same	Same	Same
Joint Point of Diversion	Included	Same	Excess Banks capacity shared 50/50 between CVP and EWA (Excess Banks capacity; reserved for EWA)	Excess Banks capacity shared 50/50 between CVP and EWA (Excess Banks capacity; reserved for EWA)
CVP/SWP Coordinated Operations				
Sharing of Responsibility for In-Basin-Use	Coordinated Operations Agreement	Same	Same	Same
Sharing of Surplus Flows	Coordinated Operations Agreement	Same	Same	Same
Sharing of Restricted Export Capacity	Equal sharing of export capacity under SWRCB D-1641	Same	Same	Same
SWRCB Decision 1643 Requirements				

	Study 1: No-Action Base Alternative	Study 2: Water Supply	Study 3: Water Supply/EWA	Study 4: Water Supply/EWA/ERP
Diversion and Release Criteria for storage on Webb Tract and Bacon Island	Not included	Included. See Section 2.2.8.1	Included. See Section 2.2.8.1	Included. See Section 2.2.8.1
CALFED Environmental Water Account				
Actions and Assets	Not included	Not included	Included (EWA Delta actions and assets not modeled)	Included (EWA Delta actions and assets not modeled)
CALFED Ecosystem Restoration Program				
Delta ERP Flows	Not included	Not included	Not included	Delta ERP flows of 20,000cfs, 30,000cfs and 40,000cfs will be met from In-delta storage for 10 days in March, April/May.

Appendix C – Study Specifications

Study 1: No-Action Base

1. 2020 hydrology and LOD
2. based on D1641 Benchmark study (all rules remain the same except for the following)
3. Fisheries Revised Banks permitted capacity (8500 cfs 01Oct – 15Mar; 6680 cfs 16Mar – 30Jun; 8000 cfs 01Jul – 30Sep)
4. Joint point of diversion wheeling for the CVP through Banks.
5. No export index constraint on CVP allocations.

Study 2: Water Supply

1. Specifications of Study 1 plus…
2. Incorporated IDS diversions and discharges into SWP and CVP operations according to the Coordinated Operation Agreement.
3. IDS diversion and discharge was limited by all requirements specified in D1643 except those pertaining to DOC, salinity, temperature, and dissolved oxygen.
4. Assumed FMWT Index > 239 for purposes of implementation of D1643.
5. IDS diversion was not bound by the maximum export to inflow (EI) ratio specified in the WQCP.
6. Assumed island discharge has salinity water quality benefit such that discharge for export was allowed to exceed ANN constraints.
7. Island diversions were subject to salinity constraints specified in the Water Quality Control Plan and implemented in the model with ANN.
8. IDS storage was allocated to meet SWP demands on the first of the month from January to May.
9. Any IDS storage that the SWP determined it had demand for could then be released for SWP export or SWP in-basin use obligations as accounted for under COA.
10. Any IDS storage that the SWP did not have a demand for on May 1 was allocated to meet CVP demands.
11. Any IDS storage that the CVP determined it had demand for could then be released for CVP export or CVP in-basin use obligations as accounted for under COA.
12. Any remaining IDS storage that the CVP did not have demand for on May 1 was made available to two supplemental demands that were not applied in the base. The demands were south of Delta Level 4 refuge demand (L4) and Kern County groundwater recharge demand (KC).
13. L4 was calculated as the difference between Level 4 demand and Level 2 demand. Level 2 demand was already included in the base and project studies. The monthly L4 in TAF was :

May	Jun	July	Aug	Sep	Oct	Nov	Dec
19	15	13	15	7	9	4	3

14. KC rate of delivery could not exceed 1600 cfs and monthly demand capped delivery as follows in TAF:

May	Jun	July	Aug	Sep	Oct	Nov	Dec

62	60	62	62	60	62	60	62

15. IDS water was delivered to L4 and KC only when export capacity was available. All other demands took precedence over the supplemental demands.
16. Delivery for L4 was given priority over KC. After L4 used the export capacity it needed, KC could use remaining capacity.
17. Supplemental demands were not met when surplus water was available in the Delta. The reason for this was that the base would have been able to meet this demand also without any impact to storage.
18. Any water remaining in IDS at the end of December reverted back to SWP control on January 1 for the start of its yearly delivery allocations.

Study 3: Water Supply and EWA

1. Specifications of Study 2 plus…
2. Unlimited EWA demand for IDS water from May to December. The only limits on delivery of IDS water to SOD EWA demand was volume of water available, island discharge capacity, and export capacity.
3. Any water that was not needed by the SWP and CVP as of May 1 could be purchased for L4, KC, or EWA.
4. EWA delivery was given lowest priority. L4 and KC demand were met first and remaining capacity was used for EWA.
5. From July to September, Banks permitted capacity was increased from 8000 cfs to 8500 cfs with the extra 500 cfs dedicated solely to the export of EWA water.
6. L4, KC, and EWA water was not discharged for export when the Delta was in surplus for the same reason provided for Study 2.

Study 4: Water Supply and EWA and Environmental Restoration Program (ERP)

1. Specifications of Study 3 plus…
2. Demand for Delta outflow releases as specified by ERP targets for given Sacramento River year types:

Critical	Dry	BN	AN	Wet
0 cfs	20,000 cfs	30,000 cfs	40,000 cfs	0 cfs

3. When Delta outflow was below the target for the given year type, IDS releases could be made to bring Delta outflow up to that target. ERP releases from IDS were limited to 10 days in March and 10 days in April and May combined.
4. In March and April, any water the SWP did not have a demand for in the March 1 and April 1 allocations could be used for ERP releases.
5. ERP releases had lower priority than SWP releases in March and April. Island discharge capacity was used first for SWP releases. Remaining discharge capacity could be used to for ERP releases.
6. Any water that the SWP and CVP did not have demand for on May 1 could be used by L4, KC, EWA, or ERP.

7. In May, ERP had lowest priority for use of island discharge capacity. Discharge was first made for L4, KC, and EWA when possible and remaining discharge capacity could be used for an ERP release when there was demand.
8. Since surplus Delta outflow was a demand in March (ERP), no diversions to island storage, which reduced Delta outflow, were allowed at this time. Diversions in April and May were precluded by D1643.

Study 4a: Initial Project Conditions w/ DOC Constraints Applied

1. Specifications of Study 4 plus…
2. Add D1643 DOC constraints as follows…
3. Island discharge was ceased if the 14 day average DOC concentration at Tracy, Banks, or Contra Costa exceeded the 1 mg/L allowed increase from the base level 14 day average DOC concentration. Discharge operations could resume once the 14 day average DOC concentration was reduced to within the allowed difference.
4. If the base level 14 day average DOC concentration was between 3 and 4 mg/L at Tracy, Banks, or Contra Costa, island discharge was ceased if the 14 day average DOC concentration at that export location exceeded 4 mg/L. Discharge operations could resume once the 14 day average DOC concentration was at or below the 4 mg/L standard.

Study 4b: DOC Dilution through Circulation

1. Specifications of Study 4a plus…
2. DOC concentration of island storage diluted through circulation.
3. Maximum circulation rate of 500 cfs per island allowed.
4. Circulation only occurred when DOC concentrations in the channel adjacent to intakes was lower than the DOC concentrations of island storage.
5. Circulation only occurred when diversion and discharge capacity were available.
6. In circulation operation, diversion equaled discharge and had no net impact on the Delta water balance.
7. In circulation, the DOC concentration of the discharge was assumed to be the island storage DOC concentration at the beginning of the day.
8. DOC discharge from circulation was subject to the constraints on export DOC concentrations set in Study 4a. Circulation was ceased if standards were exceeded

Study 4c: Fish and Aquatic Habitat Protections during Drought and Extreme Conditions (FMWT < 239)

1. Specifications of Study 4 but…
2. Assumed FMWT < 239. This had the following implications under D1643…
   a. No diversions to island storage were allowed from February 15 to June 30.
   b. The San Joaquin River diversion limit was applied for 30 days December to March rather than 15.
   c. The percent of San Joaquin River Delta inflow that could be diverted was reduced from 125% to 50% in February.

Study 4d: Climate Change Impact

1. Specifications of Study 4 but…
2. Inflows of the 2020 hydrology were shifted in time to reflect greater rainfall runoff during the winter and less snowmelt during the spring and summer. This new hydrology was run for both a base and this project study for purposes of comparison.

Study 4e: Coordination with Los Vaqueros Expanded Reservoir

1. Specifications of Study 4 with…
2. Los Vaqueros Reservoir with 500 TAF capacity.
3. Demand of 155 TAF per year on Los Vaqueros included evaporation and other losses. Demand is uniformly spread throughout each year.
4. Diversion capacity to Los Vaqueros was 1750 cfs.
5. LV diversions were subject to all D1641 operational constraints except, as with island diversions, it was assumed that LV diversions were not subject to the EI ratio.
6. Salinity constraints of the Water Quality Control plan were imposed on LV and IDS diversions through ANN.
7. LV diversions, unlike the IDS, were not subject to D1643 except…
8. No diversion to LV allowed in April and May, and…
9. Diversion to islands and LV could not exceed percentage of available surplus water as specified in D1643.
10. Priority was given to IDS diversion of surplus water available to both IDS and LV.

Study 4f: Impact of D1643 on In-Delta Storage Operations

1. Specifications of Study 4 but…
2. Removed all D1643 operational constraints except…
3. Did not allow diversions in April and May , and ...
4. Islands could only divert a percentage of available surplus water as specified in D1643 (90% Aug-Jan; 50% Mar and Jun; 75% Feb and Jul; 0% Apr and May).